This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

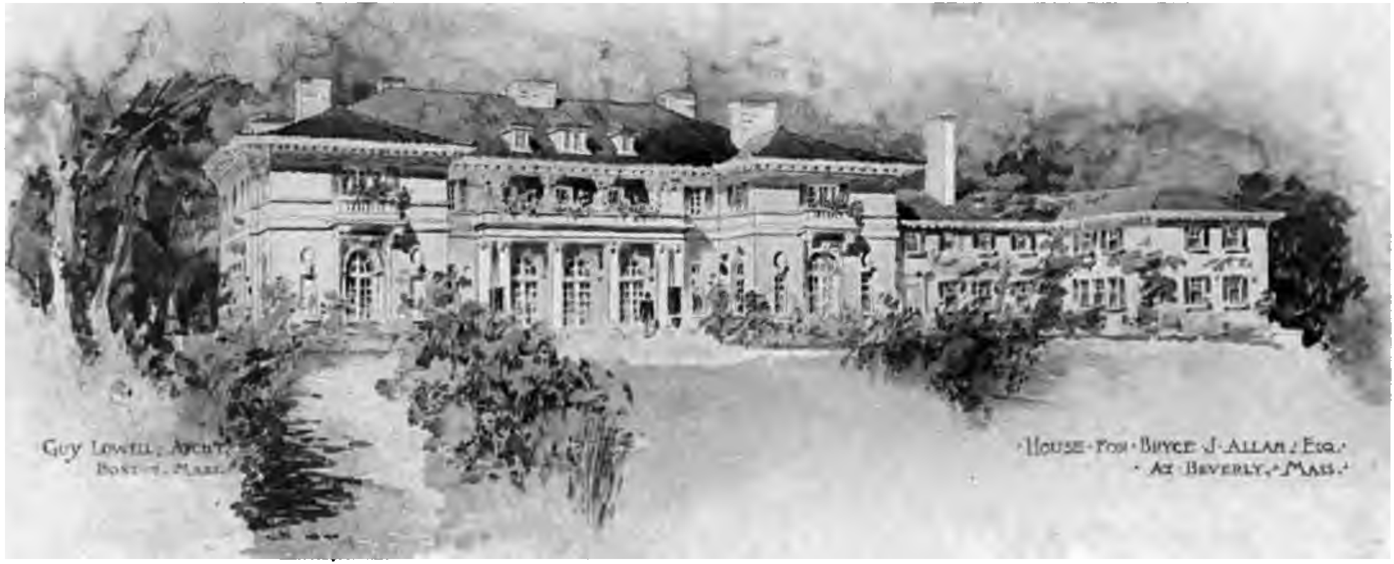
Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

LIBRARY OF THE
UNIVERSITY OF MICHIGAN

The Gift of

Leonard B. Willeke

Architect


Guy Lowell, Archt.
Boston, Mass.
House for Bryce J. Allan, Esq.
At Beverly, Mass.

RESIDENCE OF BRYCE J. ALLAN, ESQ., BEVERLY, MASS.
Guy Lowell, Architect, Boston, Mass. For plan, see next succeeding plate.

Cyclopedia
of
Architecture, Carpentry, and Building

A General Reference Work on

ARCHITECTURE, CARPENTRY, BUILDING, STRUCTURAL DRAFTING, STEEL CONSTRUCTION, MASONRY, REINFORCED CONCRETE, SUPERINTENDENCE, CONTRACTS, SPECIFICATIONS, ESTIMATING, BUILDING LAW, MECHANICAL AND ARCHITECTURAL DRAWING, FREEHAND AND PERSPECTIVE DRAWING, ROMAN AND GREEK ORDERS, ELECTRIC WIRING AND LIGHTING, HEATING, VENTILATION, PLUMBING, ETC.

Prepared by a Staff of

ARCHITECTS, BUILDERS, ENGINEERS, AND EXPERTS OF THE HIGHEST PROFESSIONAL STANDING

Illustrated with over Three Thousand Engravings

TEN VOLUMES

CHICAGO
AMERICAN TECHNICAL SOCIETY
1917

Architecture

COPYRIGHT, 1907, 1909, 1912, 1916
BY
AMERICAN TECHNICAL SOCIETY

Copyrighted in Great Britain
All Rights Reserved

Authors and Collaborators

H. V. VON HOLST, A. B., S. B.

Architect, Chicago
Member, American Institute of Architects

◆

WALTER LORING WEBB, C. E.

Consulting Civil Engineer
Member, American Society of Civil Engineers
Author of "Railroad Construction," "Economics of Railroad Construction," etc.

◆

J. R. COOLIDGE, JR., A. M.

Architect, Boston
Acting Director, Museum of Fine Arts, Boston

◆

HENRY J. BURT, B. S., C. E.

Structural Engineer for Holabird & Roche, Architects
Member, American Society of Civil Engineers
Member, Western Society of Civil Engineers
Member, Society for the Promotion of Engineering Education

◆

FRED T. HODGSON

Architect and Editor
Member, Ontario Association of Architects
Author of "Modern Carpentry," "Architectural Drawing, Self-Taught," "The Steel Square," "Modern Estimator," etc.

◆

FRANK O. DUFOUR, C. E.

Structural Engineer with Interstate Commerce Commission, Division of Valuation, Central District
Formerly Assistant Professor of Structural Engineering, University of Illinois
Member, American Society of Civil Engineers
Member, American Society for Testing Materials

◆

WM. H. LAWRENCE, S. B.

Professor of Architectural Engineering, Massachusetts Institute of Technology

Authors and Collaborators—Continued

EDWARD NICHOLS
Architect, Boston

* * *

H. W. GARDNER, S. B.
Associate Professor of Architecture, Massachusetts Institute of Technology

* * *

HERBERT E. EVERETT
Professor of the History of Art, University of Pennsylvania

* * *

FRANK A. BOURNE, S. M.
Architect
Fellow, Boston Society of Architects
Associate, American Institute of Architects

* * *

EDGAR S. BELDEN
Vice President, George A. Fuller Construction Company, Kansas City, Mo.

* * *

GEORGE C. SHAAD, E. E.
Professor of Electrical Engineering, University of Kansas

* * *

GLENN M. HOBBS, Ph. D.
Secretary and Educational Director, American School of Correspondence
Formerly Instructor, Department of Physics, University of Chicago
American Physical Society

* * *

WM. G. SNOW, S. B.
Steam Heating Specialist
Author of "Furnace Heating," Joint Author of "Ventilation of Buildings"
American Society of Mechanical Engineers

* * *

ELIOT N. JONES, LL. B.
Of the Boston Bar

Authors and Collaborators--Continued

FRANK CHOUTEAU BROWN

Architect, Boston
Author of "Letters and Lettering"

◆

EDWARD R. MAURER, B. C. E.

Professor of Mechanics, University of Wisconsin
Joint Author of "Principles of Reinforced Concrete Construction"

◆

OTIS W. RICHARDSON, LL. B.

Of the Boston Bar

◆

CHESTER L. POST, M. S.

Vice President of Condron Company, Structural Engineer, Chicago
Member of American Society of Civil Engineers

◆

ALVAH HORTON SABIN, C. E.

Lecturer in New York University
Author of "Technology of Paint and Varnish," etc.
American Society of Mechanical Engineers

◆

CHAS. B. BALL

Chief Sanitary Inspector, City of Chicago
American Society of Civil Engineers

◆

SIDNEY T. STRICKLAND, S. B.

Massachusetts Institute of Technology
École des Beaux Arts, Paris

◆

ERVIN KENISON, S. B.

Associate Professor of Mechanical Drawing, Massachusetts Institute of Technology

◆

CHAS. L. HUBBARD, S. B., M. E.

Consulting Engineer on Heating, Ventilating, Lighting, and Power
Formerly with S. Homer Woodbridge Co.

Authors and Collaborators—Continued

W. HERBERT GIBSON, B. S., C. E.
Civil Engineer and Designer of Reinforced Concrete

◆

D. A. GREGG
Teacher in Pen and Pencil Rendering, Massachusetts Institute of Technology

◆

JAMES C. PLANT
Superintendent of Computing Division, Office of Supervising Architect, Washington, D.C.

◆

DANA PIERCE, B. A.
Electrical Engineer, Underwriters' Laboratories, Inc.

◆

MORRIS WILLIAMS
Writer and Expert on Carpentry and Building

◆

WM. NEUBECKER
Instructor, Sheet Metal Department of New York Trade School

◆

WM. BEALL GRAY
Sanitary Engineer
Member, National Association of Master Plumbers

◆

GILBERT TOWNSEND, S. B.
With Ross & McFarlane, Montreal

◆

JESSIE M. SHEPHERD, A. B.
Head, Publication Department, American Technical Society

Authorities Consulted

THE editors have freely consulted the standard technical literature of America and Europe in the preparation of these volumes. They desire to express their indebtedness particularly to the following eminent authorities whose well-known works should be in the library of everyone connected with building.

Grateful acknowledgment is here made also for the invaluable cooperation of the foremost architects, engineers, and builders in making these volumes thoroughly representative of the very best and latest practice in the design and construction of buildings; also for the valuable drawings and data, suggestions, criticisms, and other courtesies.

J. B. JOHNSON, C. E.

Formerly Dean, College of Mechanics and Engineering, University of Wisconsin
Author of "Engineering Contracts and Specifications," "Materials of Construction," Joint Author of "Theory and Practice in the Designing of Modern Framed Structures"

◆

JOHN CASSAN WAIT, M. C. E., LL. B.

Counselor-at-Law and Consulting Engineer; Formerly Assistant Professor of Engineering at Harvard University
Author of "Engineering and Architectural Jurisprudence"

◆

T. M. CLARK

Fellow of the American Institute of Architects
Author of "Building Superintendence," "Architect, Builder, and Owner before the Law"

◆

FRANK E. KIDDER, C. E., Ph. D.

Consulting Architect and Structural Engineer; Fellow of the American Institute of Architects
Author of "Architects' and Builders' Pocket Book;" "Building Construction and Superintendence; Part I, Masons' Work; Part II, Carpenters' Work; Part III, Trussed Roofs and Roof Trusses;" "Churches and Chapels"

◆

N. CLIFFORD RICKER, D. Arch.

Professor of Architecture, University of Illinois
Author of "Simplified Formulas for Floors and Roofs"

◆

W. R. WARE

Formerly Professor of Architecture, Columbia University
Author of "Modern Perspective"

Authorities Consulted—Continued

CLARENCE A. MARTIN

Professor of Architecture at Cornell University
Author of "Details of Building Construction"

◆

FRANK N. SNYDER

Architect
Author of "Building Details"

◆

CHARLES H. SNOW

Author of "The Principal Species of Wood, Their Characteristic Properties"

◆

OWEN B. MAGINNIS

Author of "How to Frame a House, or House and Roof Framing"

◆

HALBERT P. GILLETTE, C. E.

Author of "Handbook of Cost Data for Contractors and Engineers"

◆

OLIVER COLEMAN

Author of "Successful Houses"

◆

CHAS. E. GREENE, A. M., C. E.

Formerly Professor of Civil Engineering, University of Michigan
Author of "Structural Mechanics"

◆

LOUIS de C. BERG

Author of "Safe Building"

◆

FRANK R. WALKER

Author of "The Building Estimator's Reference Book"

◆

IRA O. BAKER

Professor of Civil Engineering, University of Illinois
Author of "A Treatise on Masonry Construction"

◆

GEORGE P. MERRILL

Author of "Stones for Building and Decoration"

◆

FREDERICK W. TAYLOR, M.E., and SANFORD E. THOMPSON, S. B., C.E.

Joint Authors of "A Treatise on Concrete, Plain and Reinforced"

Authorities Consulted—Continued

A. W. BUEL and C. S. HILL

Joint Authors of "Reinforced Concrete"

* * *

NEWTON HARRISON, E. E.

Author of "Electric Wiring, Diagrams and Switchboards"

* * *

FREDERICK E. TURNEAURE, C. E., Dr. Eng.

Dean of the College of Engineering and Professor of Engineering, University of Wisconsin

Joint Author of "Public Water Supplies," "Theory and Practice of Modern Framed Structures," "Principles of Reinforced Concrete Construction"

* * *

J. R. CRAVATH and V. R. LANSINGH

Joint Authors of "Practical Illumination"

* * *

JOSEPH KENDALL FREITAG, B. S., C. E.

American Society of Civil Engineers

Author of "Architectural Engineering," "Fireproofing of Steel Buildings," "Fire Prevention and Fire Protection"

* * *

WILLIAM H. BIRKMIRE, C. E.

Author of "Planning and Construction of High Office Buildings," "Architectural Iron and Steel, and Its Application in the Construction of Buildings," "Compound Riveted Girders," "Skeleton Structures," etc.

* * *

EVERETT U. CROSBY and HENRY A. FISKE

Joint Authors of "Handbook of Fire Protection for Improved Risk"

* * *

CARNEGIE STEEL COMPANY

Authors of "Pocket Companion, Containing Useful Information and Tables Appertaining to the Use of Steel"

* * *

ALPHA PIERCE JAMISON, M. E.

Assistant Professor of Mechanical Drawing, Purdue University

Author of "Advanced Mechanical Drawing"

* * *

H. G. RITCHEY

Superintendent of Construction, U. S. Public Buildings

Author of "A Handbook for Superintendents of Construction, Architects, Builders, and Building Inspectors"

Authorities Consulted—Continued

HENRY McGOODWIN

Author of "Architectural Shades and Shadows"

◆

VIGNOLA

Author of "The Five Orders of Architecture," American Edition by Prof. Ware

◆

CHAS. D. MAGINNIS

Author of "Pen Drawing, An Illustrated Treatise"

◆

FRANZ S. MEYER

Professor in the School of Industrial Art, Karlsruhe
Author of "Handbook of Ornament," American Edition

◆

RUSSELL STURGIS

Author of "A Dictionary of Architecture and Building," and "How to Judge Architecture"

◆

A. D. F. HAMLIN, A. M.

Professor of Architecture at Columbia University
Author of "A Textbook of the History of Architecture"

◆

RALPH ADAMS CRAM, Litt. D.

Professor of Architecture, Massachusetts Institute of Technology
Author of "Church Building"

◆

C. H. MOORE

Author of "Development and Character of Gothic Architecture"

◆

ROLLA C. CARPENTER, C. E., M. M. E.

Professor of Experimental Engineering, Cornell University
Author of "Heating and Ventilating Buildings"

◆

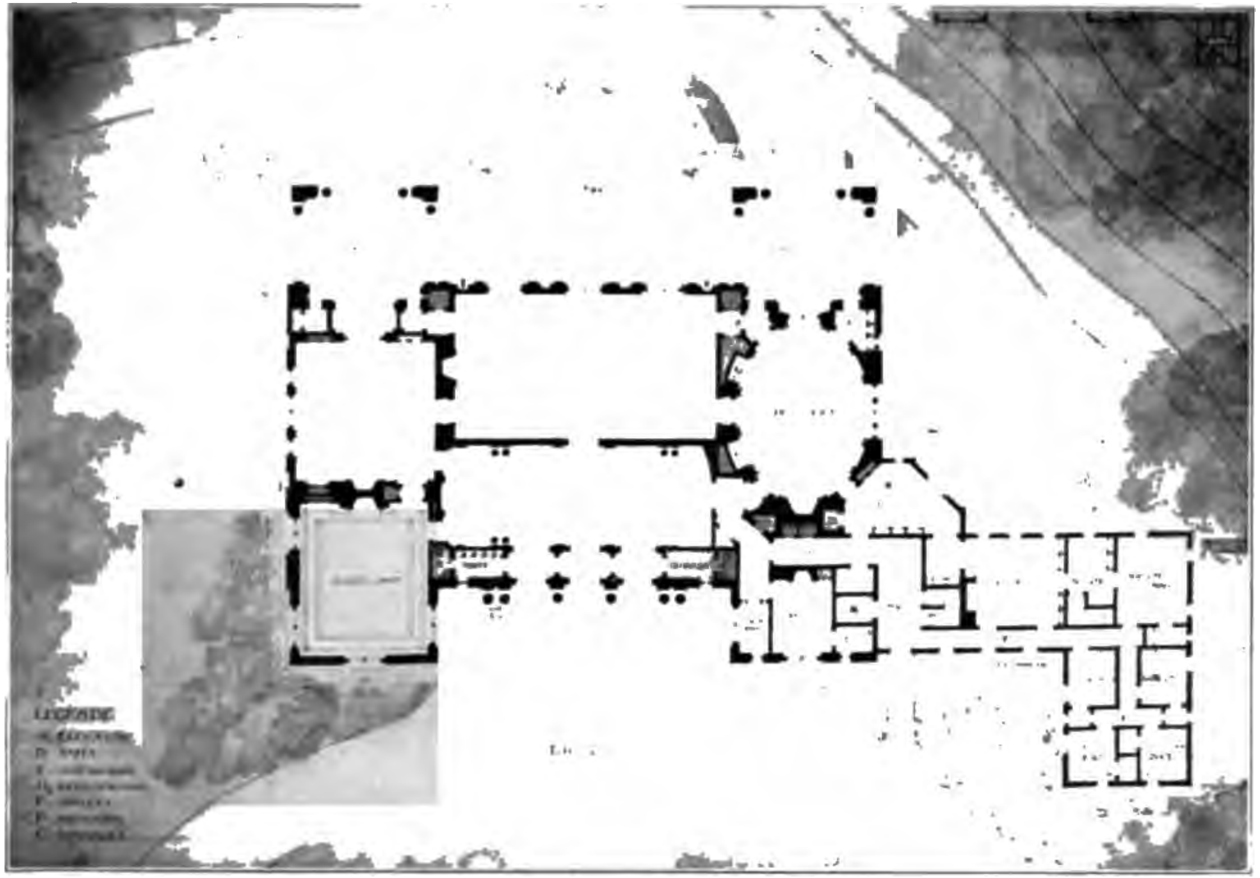
WILLIAM PAUL GERHARD

Author of "A Guide to Sanitary House Inspection," "Sanitation of Public Buildings," "Theater Fires and Panics," and "Water Supply, Sewerage and Plumbing of Modern City Buildings"

◆

I. J. COSGROVE

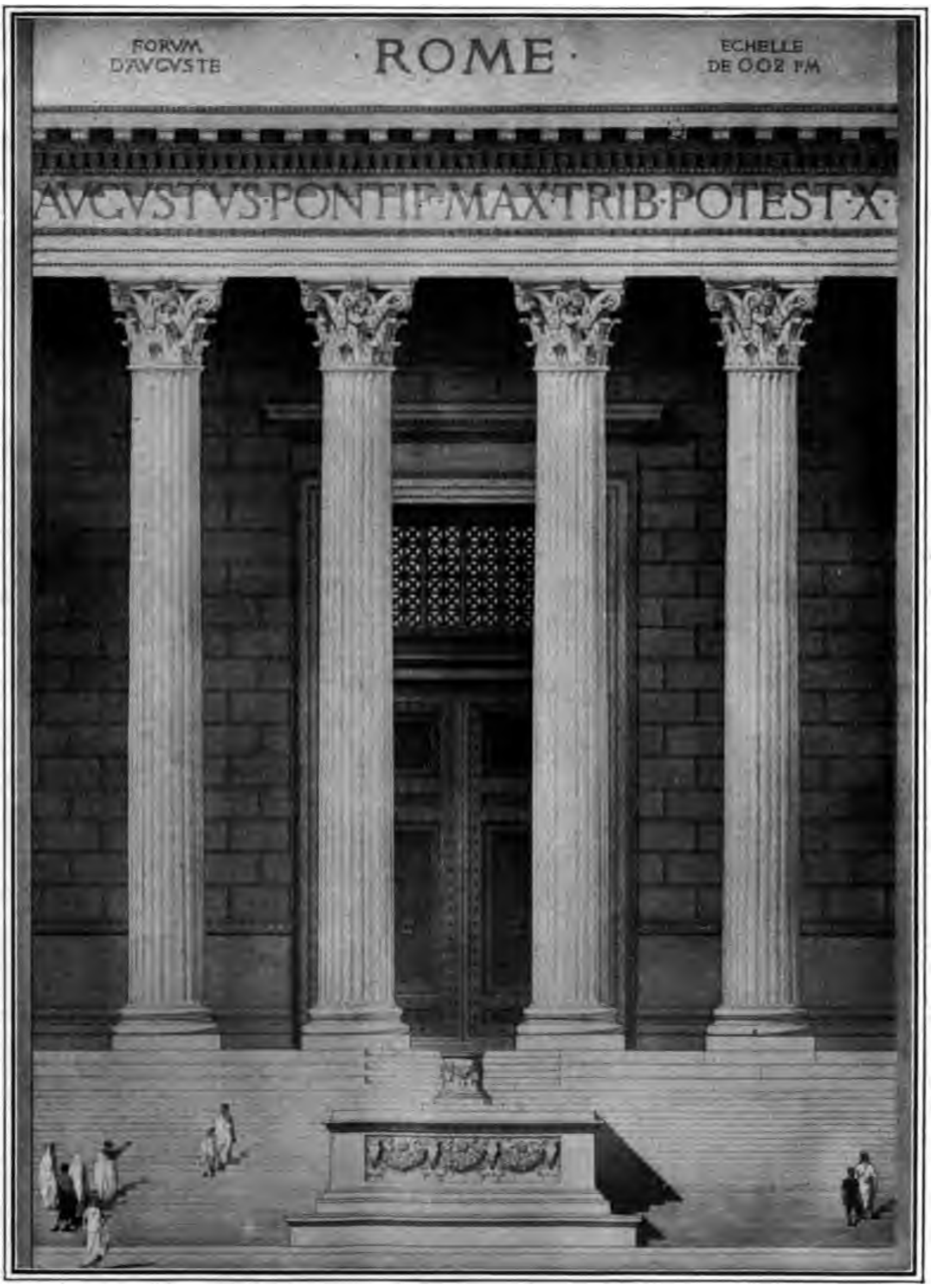
Author of "Principles and Practice of Plumbing"



PLAN OF RESIDENCE FOR BRYCE J. ALLAN, ESQ., BEVERLY, MASS.

Guy Lowell, Architect, Boston, Mass.

For Exterior View, Reproduced in Color, See Frontispiece in this Volume.



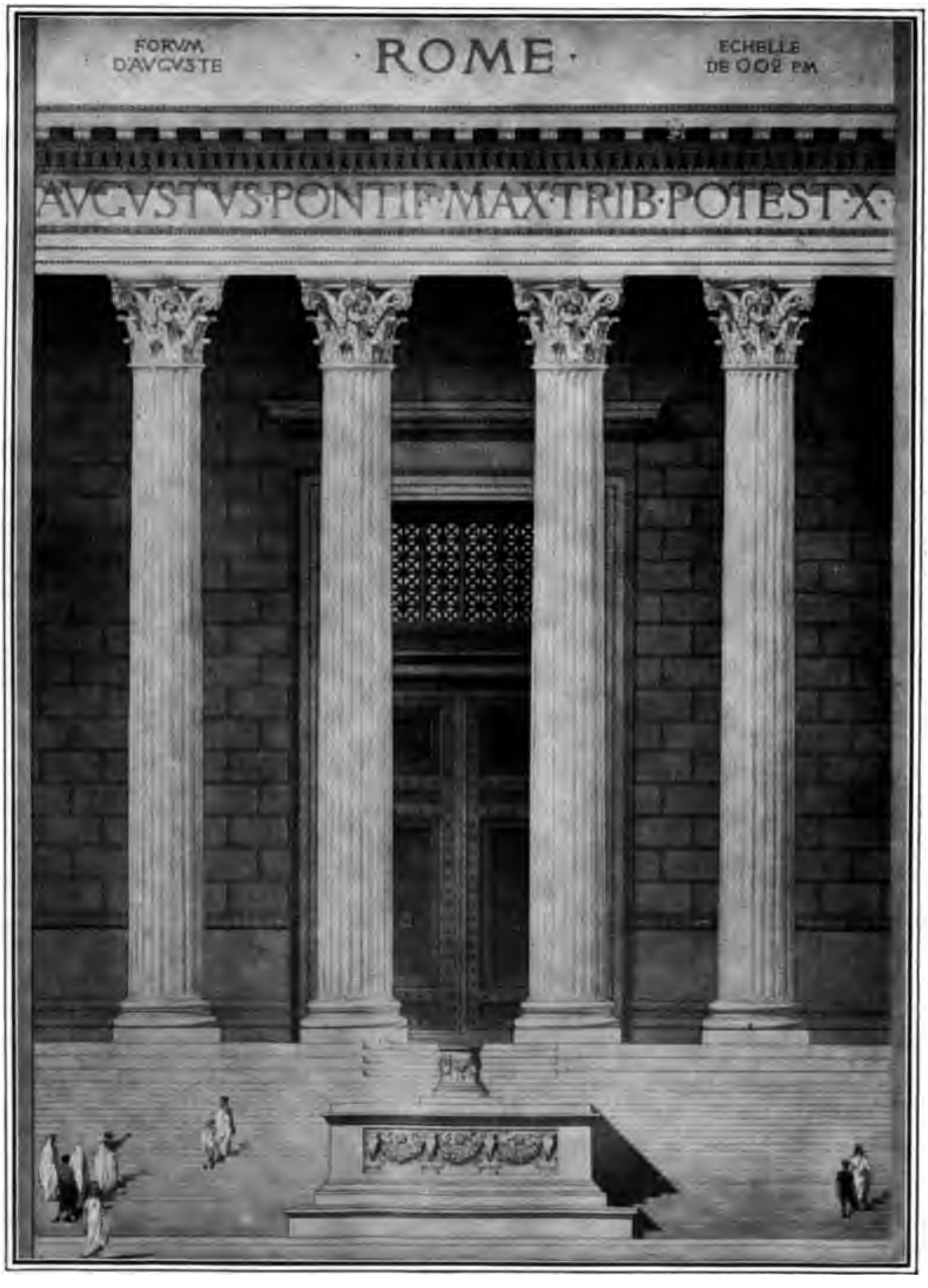
DETAIL FROM TEMPLE OF MARS VENGEUR
An example of classic lettering, conventional shadows and rendering
Reproduced by Permission of Massachusetts Institute of Technology

Foreword

THE rapid evolution of constructive methods in recent years, as illustrated in the use of steel and concrete, and the increased size and complexity of buildings, has created the necessity for an authority which shall embody accumulated experience and approved practice along a variety of correlated lines. The Cyclopedia of Architecture, Carpentry, and Building is designed to fill this acknowledged need.

¶ There is no industry that compares with Building in the close interdependence of its subsidiary trades. The Architect, for example, who knows nothing of Steel or Concrete construction is today as much out of place on important work as the Contractor who cannot make intelligent estimates, or who understands nothing of his legal rights and responsibilities. A carpenter must now know something of Masonry, Electric Wiring, and, in fact, all other trades employed in the erection of a building; and the same is true of all the craftsmen whose handiwork will enter into the completed structure.

¶ Neither pains nor expense have been spared to make the present work the most comprehensive and authoritative on the subject of Building and its allied industries. The aim has been, not merely to create a work which will appeal to the trained expert, but one that will commend itself also to the beginner



DETAIL FROM TEMPLE OF MARS VENGEUR
An example of classic lettering, conventional shadows and rendering
Reproduced by Permission of Massachusetts Institute of Technology

Foreword

THE rapid evolution of constructive methods in recent years, as illustrated in the use of steel and concrete, and the increased size and complexity of buildings, has created the necessity for an authority which shall embody accumulated experience and approved practice along a variety of correlated lines. The Cyclopedia of Architecture, Carpentry, and Building is designed to fill this acknowledged need.

¶ There is no industry that compares with Building in the close interdependence of its subsidiary trades. The Architect, for example, who knows nothing of Steel or Concrete construction is today as much out of place on important work as the Contractor who cannot make intelligent estimates, or who understands nothing of his legal rights and responsibilities. A carpenter must now know something of Masonry, Electric Wiring, and, in fact, all other trades employed in the erection of a building; and the same is true of all the craftsmen whose handiwork will enter into the completed structure.

¶ Neither pains nor expense have been spared to make the present work the most comprehensive and authoritative on the subject of Building and its allied industries. The aim has been, not merely to create a work which will appeal to the trained expert, but one that will commend itself also to the beginner and the self-taught, practical man by giving him a working knowledge of the principles and methods, not only of his own particular trade, but of all other branches of the Building Industry as well. The various sections have been prepared especially for home study, each written by an acknowledged authority on the subject. The arrangement of matter is such as to carry the student forward by easy stages. Series of review questions are inserted in each volume, enabling the reader to test his knowledge and make it a permanent possession. The illustrations have been selected with unusual care to elucidate the text.

❡ The work will be found to cover many important topics on which little information has heretofore been available. This is especially apparent in such sections as those on Steel Construction; Reinforced Concrete Construction; Building Superintendence; Estimating; Contracts and Specifications, including the principles and methods of awarding and executing Government contracts; and Building Law.

❡ In conclusion, grateful acknowledgment is due the staff of authors and collaborators, without whose hearty co-operation this work would have been impossible.

Table of Contents

VOLUME VII

Architectural Drawing . . . .
By F. A. Bourne and H. V. von Holst† Page *11

Instruments—Materials—Tinted Papers—Tracing Paper—Tracing Cloth—Line Drawing—Axes—Limiting Lines—Oblique Projections—Modeling Drawings—Shadows—Values—Rendering in Wash—Grading Tints—Combination of Color—Water-Color Rendering—Sketching—Architectural Design—Method of *École des Beaux Arts*—Exhibition Drawings—Measured Work—Datum Lines—Approximations—Rubbings—Practical Problems in Design—Composition—Scale—Ornament—Design of the Dwelling—Building a House—Buildings for Offices—Design of Colonial House—Basement Plan—Floor Plans—Elevations—Framing Plans—Details—Uniform Titles for Drawings

Architectural Lettering . . . *By F. C. Brown* Page 115

Office Lettering—Letter Forms—Skeleton Letters—Composition—Spacing—Minuscule Letters—Inscription Lettering—Italian Renaissance Forms—Uncial Gothic Capitals—Inscription Letter Sections—Classic Roman Letters—English 17th Century Letters—Black-Letter Alphabet—Gothic Lettering

Freehand Drawing . . . . *By H. E. Everett* Page 165

General Principles — Learning to See — Outline — Holding the Pencil — Freehand Perspective—Horizon Line or Eye-Level—Foreshortened Planes and Lines—Parallel Lines—The Square—The Triangle—The Prism—The Cylinder—The Cone — The Regular Hexagon — Concentric Circles — Frames — General Directions for Drawing—Testing Drawings by Measurement—Form Drawing—Value Drawing—Varieties of Shading—Directions of Shade Lines—Motives of Common Types of Ornament—Typical Egyptian, Assyrian, and Greek Motives—Pottery Forms—Greek Decorated Moldings—Grille Work—Byzantine Capital—Roman Corinthian Capital—Italian Renaissance Pilaster

Perspective Drawing . . . *By W. H. Lawrence* Page 229

Definitions and General Theory—Perspective Projection—Picture Plane—Station Point or Point of Sight — Vanishing Point — System — Element — Vanishing Trace — Horizon — Plane of Horizon — Planes of Projection — Method of the Revolved Plan—Lines of Measures—Vanishing Points of Oblique Lines—Vanishing Point Diagram—Parallel or One-Point Perspective Plan — Method of Perspective Plan—Curves—Apparent Distortion

Shades and Shadows . . . *By H. W. Gardner* Page 299

Shadows of Points—Shadows of Lines—Shadows of Planes—Shadows of Solids—Use of Auxiliary Planes

Rendering in Pen and Ink . . . *By D. A. Gregg* Page 359

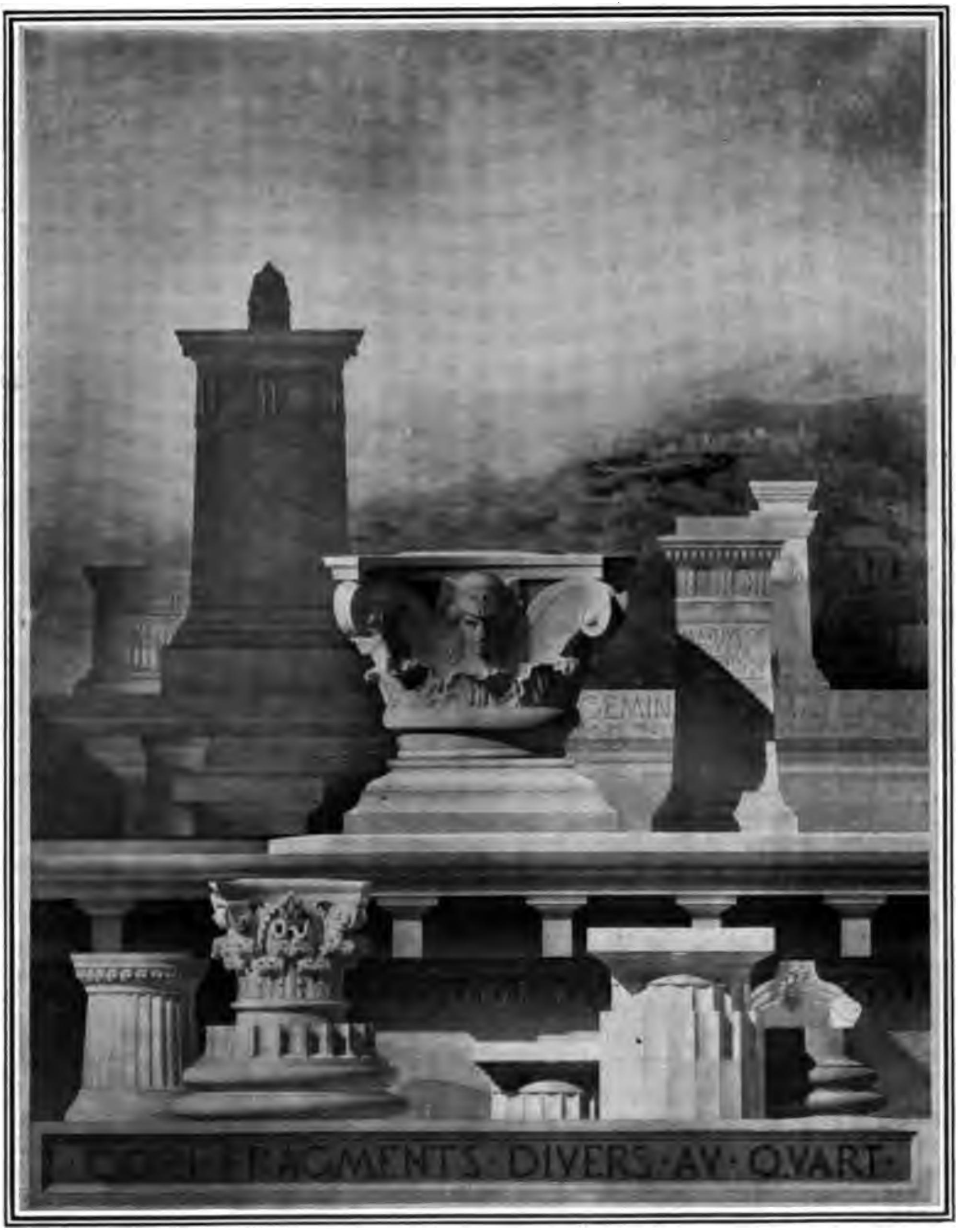
Line Work — Quality of Line — Method—Vertical Lines—Free Lines—Light and Shade—Values—Lighting—Color of Material—Principality or Accent—Pencil Work—Plates of Various Studies

Index . . . . Page 393

---

* For page numbers, see foot of pages.

† For professional standing of authors, see list of Authors and Collaborators at front of volume.


GEMIN
CORI · FRAGMENTS · DIVERS · AV · QVART ·

FRAGMENTS FROM ROMAN TEMPLE AT CORI, ITALY.

One of the most interesting examples of architectural rendering in existence.

Original drawing by Emanuel Brune.

Reproduced by permission of Massachusetts Institute of Technology.

ARCHITECTURAL DRAWING.

PART I.

Instruments and Materials. The study of mechanical drawing has acquainted the student with the use of the ordinary drawing instruments and materials. Those required for architectural work are substantially the same.

Pencils. Soft pencils are used; a draftsman cannot have advanced far in ability before becoming familiar with the B B pencil, which will draw any line, from the finest to the coarsest, and give the greatest freedom for all kinds of work, from sketching to full-size details.

In architects' offices it is an almost invariable rule for the new-fledged student and young draftsman to use hard pencils—"nails," as they are called by more experienced men. A soft pencil gives a much more agreeable expression of ideas on paper than a hard pencil; the latter should be reserved for mechanical work. The draftsman must not allow himself to become less accurate as he gains greater freedom, and the use of a soft pencil gives no excuse for a careless or slovenly drawing. H H, F and B B will be found the most useful grades. For laying out work, H H is often used.

Erasers. The noted architect, H. H. Richardson, said that "an eraser is a draftsman's best friend." For work on detail paper, a firm rubber is best, but a soft rubber is most serviceable for removing ordinary pencil marks from all kinds of paper, including the thin tracing papers, without injury to the surface. It will be found that the eraser can be frequently used in studying outlines, and it is the custom for rapid draftsmen to let the pencil lines run where they will, trusting to the eraser to make the outline true. A large size ink eraser will be found easier on the hands than a small one. In making erasures a typewriter's shield of metal with different sizes

---

For some of the text and several of the illustrations in ARCHITECTURAL DRAWING, the French work, Éléments et Théorie de l'Architecture, Vol. I., by Guadet, has been drawn on freely. The four volumes of this work by Guadet cannot be too highly recommended. Even those not familiar with the French language will find it an excellent reference work on account of the numerous useful illustrations it contains.

of openings, corresponding to the erasures to be made, called in draftsman's parlance, the "office goat," is useful. Holes can be cut in cardboard or detail paper for this purpose.

Set of Instruments. Good instruments are advisable, as it is hard enough to make good drawings, even with the best. Compasses with pencil and pen points and extension legs; large and small dividers, bow-pen and bow-pencil, and two ruling pens, form the usual equipment of the architectural draftsman's instrument case. Besides these a simple form of proportional dividers will be found very useful, especially in changing drawings from one scale to another, and also when it is desired to translate a rough sketch into a definite scale, preserving the proportions of the sketch. A small protractor will be sufficient for the rare occasions when an architect lays off angles to a given number of degrees.

Beam compasses are useful, though many offices have only long straight edges and carpenters' clamps for this purpose. Sometimes a taut string will serve the purpose where perfect accuracy is not required, or two points on a straight edge may be taken, one point being held with one hand, while a curve is struck from another point by a pencil held in the other hand.

Drawing Boards. It is necessary to have two drawing boards, one a "Double Elephant" size, 28 × 42 inches, to accommodate paper of a size called "Double Elephant," which is 27 × 40 inches, thus allowing ½ inch at the sides and an inch at the ends; the other board 23 × 32 inches, to accommodate the size of paper called "Imperial," which is 22 × 30 inches. It will be found convenient also to have a small "Half Imperial" board 23 × 16 inches in size. These boards should have a straight grained cleat at each end, or should be entirely surrounded with a framework of hard wood, having soft wood in the center. Cherry makes a good hard wood for the frames or ends, and pine or white wood for center. In many offices the boards are made entirely of pine or white wood, but it will be found preferable to have better made boards, and to take good care of them, keeping them square. If adjacent sides of the board make a true right-angle, the T-square can be used on these two sides, which is an advantage in drawing long lines. When the boards have cleats at the ends only, however, it is always necessary to use the T-square from the left-hand end only.

Triangles and T-Squares. There are T-squares to correspond to the size of the boards. They are usually made of straight, fine grained hard wood. The simplest form of fixed T-square will be found the most satisfactory for general office use. As even the best are apt to vary, it is a good idea to number every T-square in the office and note the number on commencing a drawing. If, however, the T-square is changed, and the new square does not line up with the old work, a thumb tack in the edge of the head next the drawing board may be used to bring the blade into line, as shown in Fig. 1. The drawing edge (upper edge) of a T-square should never be used as a straight edge for paper cutting.

Two triangles are required, one 30 degrees to 60 degrees, and one of 45 degrees. Triangles are made of wood, hard rubber or celluloid.

Materials for Wash-Drawings. For tinting, a nest of tinting saucers, brushes, a soft sponge, large blotters, a stick of India ink, a slate slab for grinding it, a half cake of carmine and a half tube of Prussian blue will make a good beginning.

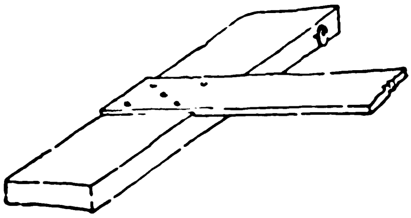


Fig. 1. T-Square with Thumb Tack.

Paper. Paper comes in certain conventional sizes. "Whatman's paper" is most easily obtained in two sizes, the "Imperial," 22 × 30 inches, and "Double Elephant," 27 × 40 inches, and is a useful paper for all-around architectural work, being good for pencilling, inking in, and wash drawings; colors can be laid on it even after erasures have been made. The Whatman "hot-pressed" paper has a smooth surface and is generally used for fine pencil or ink drawings. The Whatman "cold-pressed" paper has a rough surface and good texture, and is useful for all-around work.

Tinted Papers. Gray or other colored papers are frequently employed, pencil or pen and ink being used for the lines and shadows, and chalk or Chinese white for the high lights. Pastels and water colors are used on special colored papers; "scratch papers" are those on which white is obtained by scratching through the colored surface of the paper. Some of these papers, including buff or manila detail paper, have already been fully described under the subject of mechanical drawing. The process of stretching paper is also there described.

Tracing Paper. In architectural work a great deal of tracing paper is used. A cheap manila tracing paper is convenient for rough preliminary studies not intended to be preserved. "Alba," a white tough tracing paper, and "Economy," a cheaper form, are very good for pencil sketching and also for careful pencil drawings. Rowney's English tracing paper is very transparent, is good for accurate pencilling, and takes color, but becomes brittle with age; it is, however, the best paper for careful studies of architectural work. Bond paper which comes in sheets 20 × 28 inches, is very useful for working drawings of small frame houses, as the drawing can be inked-in and blue prints taken directly from this paper without the necessity of tracing.

Some offices make many of their details in black pencil on this paper and where work on different houses is similar, let blue prints of these details serve for each new building.

Tracing Cloth. Tracing cloth is used for important work where the tracing will be roughly used or where changes are likely to be made in the drawing. In drawing on tracing cloth, there are three ways of making the ink flow well: (1) The most common is to rub powdered chalk over the surface, dusting off the superfluous chalk; (2) Benzine applied with a towel will clean the cloth; (3) Oxgall, a preparation obtainable at any artists' materials store, may be mixed with the ink. Sometimes pencil drawings are made directly on the cloth, and after inking-in benzine is used to remove all pencil marks. As a rule, the rough side of the tracing cloth is used, but some draftsmen prefer to ink-in on the smooth side, thinking they can make a cleaner line, and then turn the cloth over to color the drawing on the rough side with water colors or crayons.

Scales. Scales for architectural work are like those used for mechanical drawing, one-quarter inch to the foot for working drawings, and three-quarter inch to the foot for details, being the customary scales used in American offices, though some offices use one-eighth inch to the foot, with one-half inch to the foot for details—the custom usually followed in England. It is customary to make full-size details of mouldings and of special constructive parts. Three-sixteenths inch to the foot is sometimes useful as a scale drawing, or in laying out stairs in section, as will be described later. This scale is also frequently used for exhibition drawings. One and one-half inch to the foot, one inch to the foot, and three inches to the foot, are also used. For the scale of three inches to the foot, the ordinary quarter-inch scale may be read as inches instead of feet, as one-quarter inch is one-twelfth of three inches. The three-quarter inch scale is the favorite among carpenters for the reason that the ordinary two-foot rule can be used on the drawings; as there are twelve-sixteenths of an inch in every three-quarters of an inch, each sixteenth of an inch on the rule represents one inch actual measurement. The inch scale is very popular for drawing mantels, interior finish, etc., where the total dimensions can be read directly from the two-foot rule, each inch being equal to the foot full size.

The accompanying illustration of an architect's scale, Fig. 2, shows the usual divisions on a scale for ordinary architectural work.

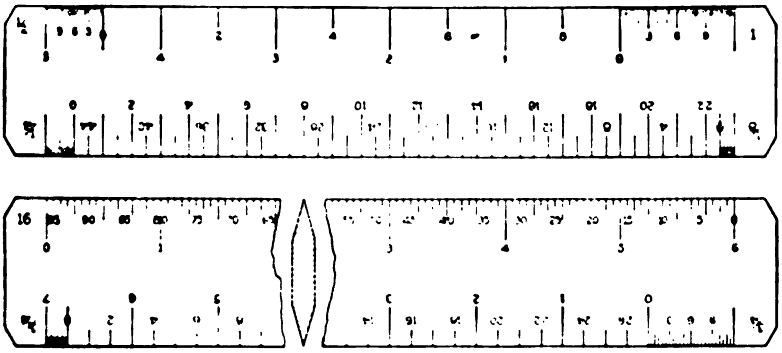


Fig. 2 Architects' Scale.

A six-inch scale of this size is very convenient for ordinary measurements and a similar one eighteen inches or two feet long is useful for laying out larger work. This scale gives the full-size measurements in inches divided into sixteenths with the scales of sixteenths reading in the reverse order from zero up, so that the number can be read directly from a sixteenth scale or doubled for a thirty-second inch scale. The common quarter-inch and eighth-inch scales are given, as well as the half-inch and one-inch scales. The useful three-quarter inch scale is given with the three-sixteenths scale in reverse order.

The accompanying sketch, Fig. 3, shows how a scale may be used in laying out staircases in plan and section much more rapidly than is usual in architects' offices. The sketch shows the plan and section of a staircase at a scale of one-quarter of an inch to the foot, the staircase to be three feet six inches wide. The section shows that the floors are nine feet six inches between finished surfaces. As it is desirable to economize space, the stairs are to be laid out with about seven and one-half inches rise and eleven inches tread. Dividing nine feet six inches by seven and one-half, we find that fifteen

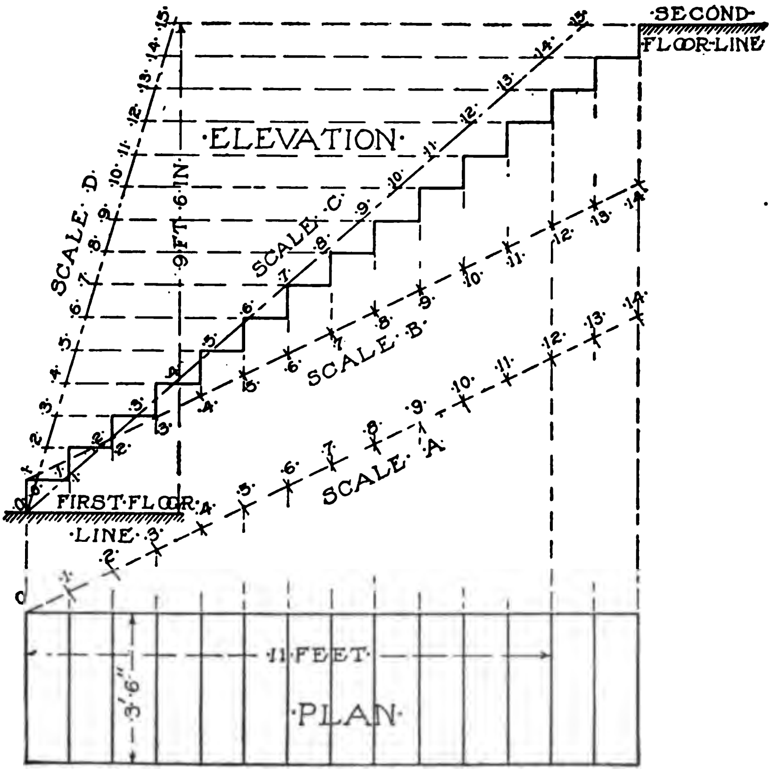
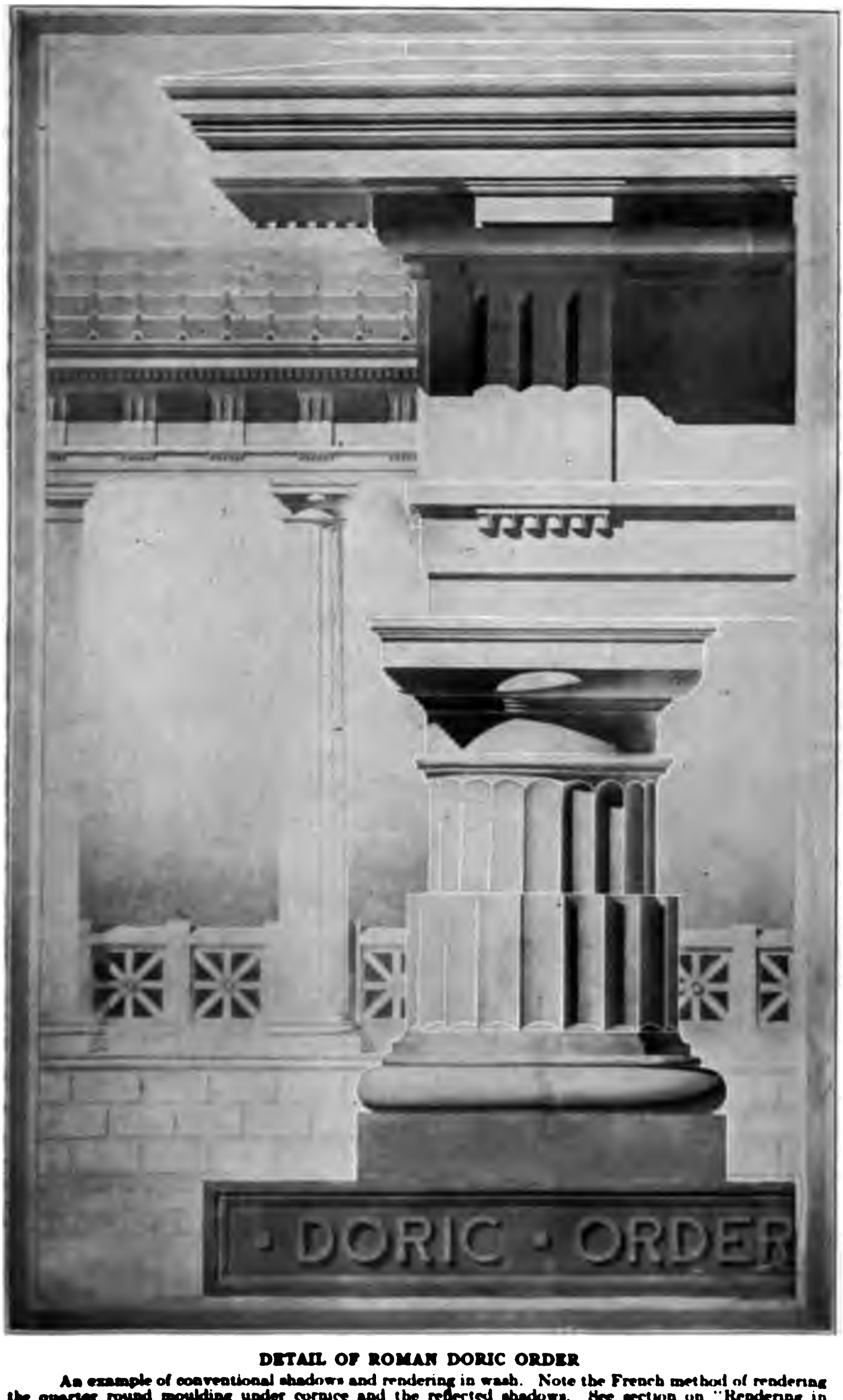


Fig. 3. Use of Scales in Laying out Stairs.

risers will give us slightly over seven and one-half inches. To lay out fourteen treads—which locate the fifteen risers including the first and last—instead of spacing over fourteen treads, start from the first riser, lay off parallel to run of stairs in plan eleven feet on the quarter-inch scale; then draw a line perpendicular to the run of the stairs. Tip the scale until the zero coincides with the first tread and twelve



DETAIL OF ROMAN DORIC ORDER

An example of conventional shadows and rendering in wash. Note the French method of rendering the quarter round moulding under cornice and the reflected shadows. See section on "Rendering in Wash" page 33

Reproduced by Permission of Columbia University

immediately in ink, between limiting lines in pencil. But the draftsman should be very sure of himself and his drawing before using this method.

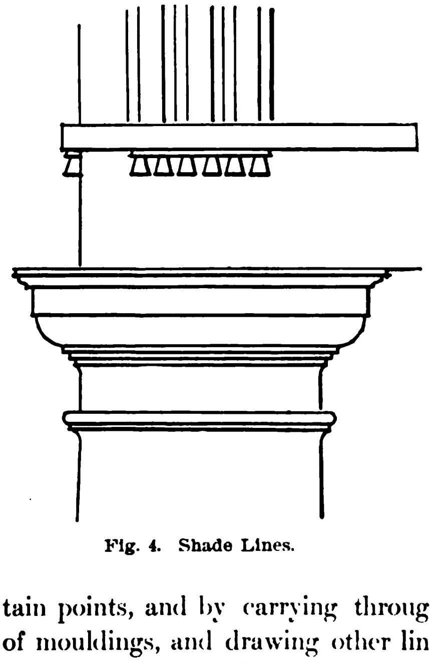


Fig. 4. Shade Lines.

Shade lining, or indicating shadows by making the lower and right-hand edges of projecting planes in elevation heavier, see Fig. 4, is used in architectural drawing, especially in illustrations for publication. In office work, when it is desired to show the shadows, the latter are generally laid in washes. The brilliancy of the architectural drawing shown in many recent examples, especially from New York offices, is much increased by strengthening the outline of projecting members and ornamental parts, by accenting certain points, and by carrying through only certain important lines of mouldings, and drawing other lines only a short distance. Finished lines coming down on to projecting surfaces may be stopped short just before reaching the surface, giving effect of high light on those surfaces, as shown in Fig. 4; and lines at outer angles may be carried slightly across each other, giving a firm intersection, instead of stopping just at the junction. For plans the same holds good, as is shown in Fig. 5.

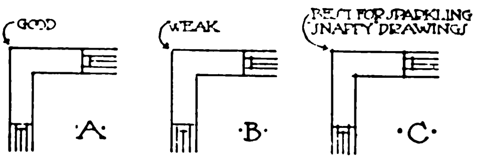
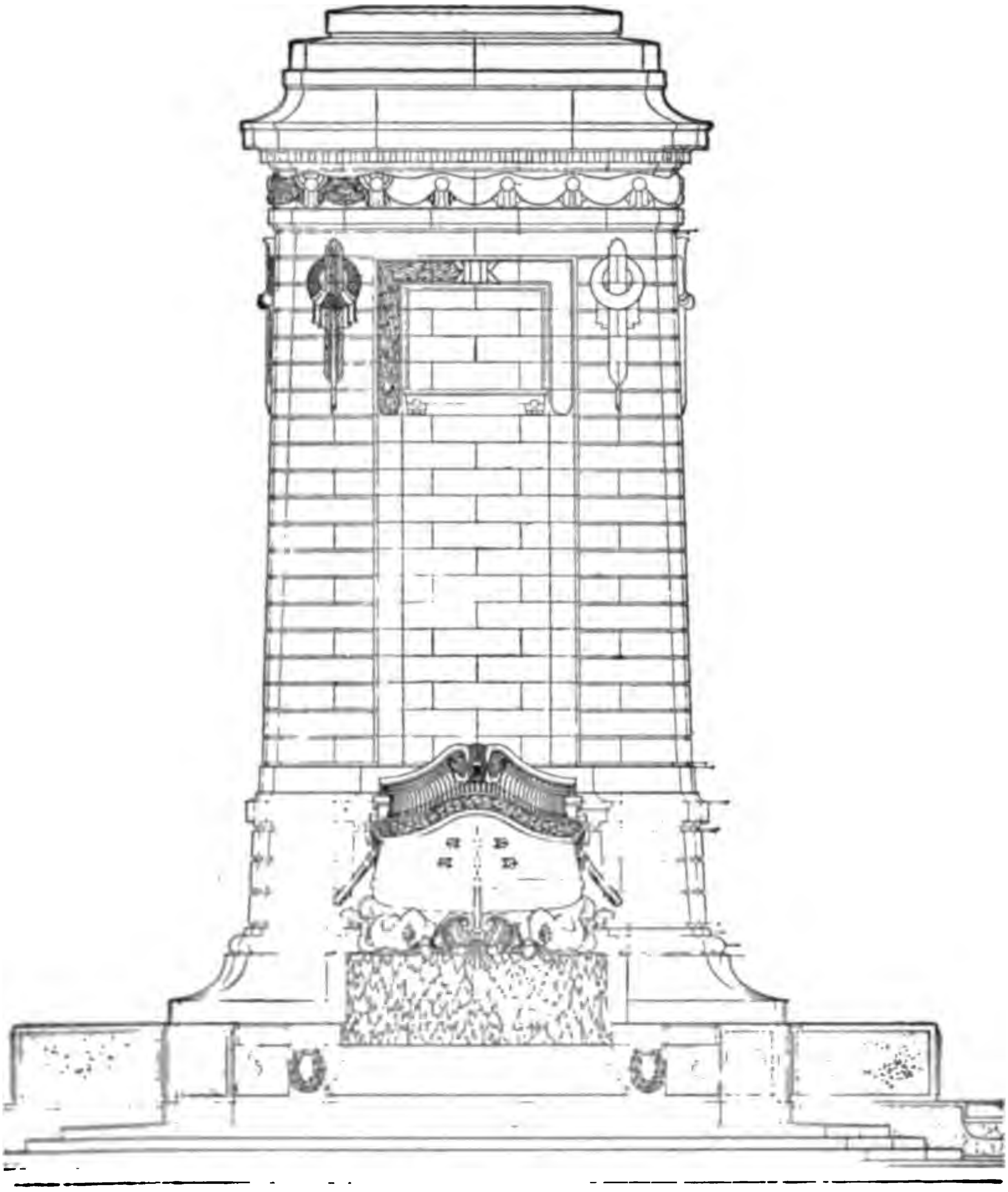


Fig. 5. Junctions of Lines.

In an elevation, the planes toward the front may be drawn with dark lines and those farther back with lighter lines. Joint lines in masonry and the lighter lines of carving should be drawn in ink which has been diluted with water. The design for the National Maine Monument, page 9, shows a good method of lining an architectural drawing.



First Prize Design. National Maine Monument.

H. Van Buren Magonigle, Architect.

Sometimes lines of different colors, as red to indicate brick, blue for stone, yellow for wood, etc., are used on working drawings to take the place of tinting.

DEFINITIONS.

Architectural drawing is geometric. If the student is making the drawing of a model, he should try to think how the author of the model laid it out, and how he, the student, would proceed if he had the opportunity to lay it out. He will find that the model is represented on paper by the different projections such as the plans, sections and elevations. These are laid out to a certain scale; that is to say, one-fourth inch to the foot, which means that one-fourth inch in the drawing represents one foot in the model; or one-eighth inch to the foot, etc.

Definition of Plan. A plan of a building is a section cut by a horizontal plane through the walls, supports, etc., at such a height so as to show the greatest number of peculiarities in construction, walls, doors, windows, supports, columns and pilasters, fireplaces, etc. It is possible to consider a plan as a horizontal impression that could be taken of the building in course of construction when it had arrived at a certain level in the height of a story. On the plan the construction is shown invariably by horizontal sections, but it is possible to project up all that is below and also to show what is above. In the first case the plan will show the architectural portions which project beyond the base of the walls or supports such as the base, steps, approaches, etc. In the other case it will show vaultings, ceilings, entablatures, cornices, etc. Sometimes it is desirable to show both—half of each—provided the parts shown are sufficiently interesting or necessary for explaining the entire scheme.

Definition of Section. The section is a plane cut through a building vertically, that is to say, it is the same thing perpendicularly that the plan is horizontally. This plane should be taken along the line of some main axis.

A single section rarely is sufficient to give all the interior of the building. It is necessary to have, as a rule, at least two, one a longitudinal section, perpendicular as a rule to the facade, and the other a transverse section, usually parallel to the facade. Very often a small section of the front alone is made. This should preferably be called a profile of the front.

Definition of Elevations. The elevations of a building are the projections of the building on vertical planes parallel to the side of the building of which an elevation is desired. Except in the case of complete uniformity, it is necessary to have several elevations in order to show the complete exterior of a building, such as the principal facade, side elevations, and rear elevation.

THE IMPORTANCE OF AXES IN ARCHITECTURAL DRAWING.

The axis is the key of a design or of any composition. An axis in geometry is a line which separates into two equal parts any symmetrical plane figure, or the pole of a surface of revolution or of a regular solid, such as a rectangular prism with a regular base. In architecture the idea of the axis is greater than this. It is in reality a vertical plane through the whole building separating the building into two parts symmetrically, or in such a way that they balance one another.

Although the graphical representation is confined to a straight line, do not forget that it is not simply a line. Take for example a church; in drawing the plan, the axis of this plan will be a straight line separating it into two parts, but this line itself will be only the projection of the central vertical plane which is the axis of the whole building; and the keystones of the vault, the lights which drop from them, the center of the rose window, etc., are *in the axis* of the church. Notice besides this that the straight line which is the axis of the plan, and the line which is the axis of the front and rear facade, the line which is the axis of the transverse section—these lines are only the traces, all belonging to some axis plane, as it may be called, and this plane is the principal axis.

But there are other minor axes. Parallel to the main axis are the axes of the side arms and between these are the axes of the columns. Running transversely are the axes of the transept, those of each bay, the radiating axes of the chapels, etc.

In laying out the drawings of a church, for example, first place all of these different axes with the utmost accuracy. This method of laying out the drawings of a building by starting with the axes may be best explained by examples. Let us commence by the study of a plan, that of a vestibule, in a public building; *e.g.*, the Hotel des Monnaies at Paris, Fig. 6.

After having drawn the axis 1, which is the principal axis of the building, it will be noticed that there are five bays of the central pavilion which are spaced equally. Of these draw first the extreme axes, 2 2; by dividing the space between axes 1 and 2 into equal parts, the intermediate axes 3 3, will be found. In this way the chances of error would be decreased, for if the axes were placed in the order 1, 3, 2, the possible error would be doubled. Now taking the portion to the right, draw first the extreme axis 4, then 5, and divide the space 4 5 into equal parts, which will give the axis 6.

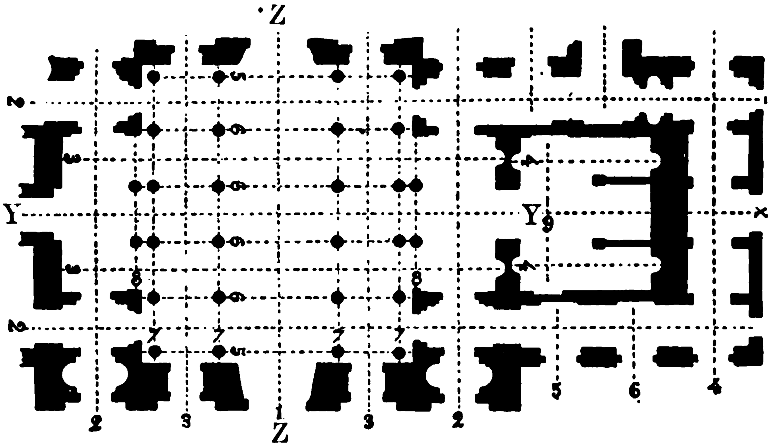


Fig. 6. Plan of Vestibule of Hotel des Monnaies.

Now consider the axes of the rows of columns 7 7. These are to be arranged in relation to the axes 3 3; finally the axes 8 8 are located in relation to the extreme axes 7 7, being checked in relation to the axes 2 2.

In the longitudinal direction the same process will be gone through, placing the first axis 1, then the extremes 2 2; by division 3 3 will be obtained, and dividing the spaces between the axes 1, 2, and 3, into half, the axes 5 and 6 of the columns are obtained. The secondary axes will be placed in the same way. Finally it will be found advisable to check up the different steps by verifying the distances of the secondary symmetrical axes from the central main axis.

In carefully studying the plan, and the different methods of drawing it, the student will become convinced that the methods of spacing the axes are of great importance, and that in this way he will arrive at exactness and will avoid many mistakes.

The student must understand that it is much more difficult to draw a good plan than is popularly supposed; more difficult, perhaps, than anything else, from the mere fact that everything builds up from the plan. In the plan especially, extreme exactness is necessary and the student will do well, in order to become familiar with architectural drawing, to practice the drawing of plans constantly.

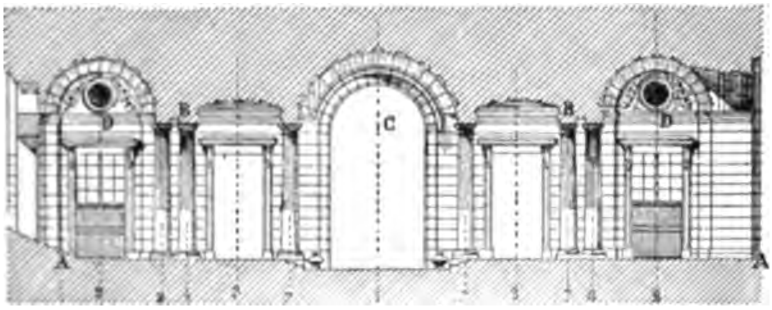


Fig. 7. Hotel des Monnaies, Transverse Section of Vestibule.
Section on YY.

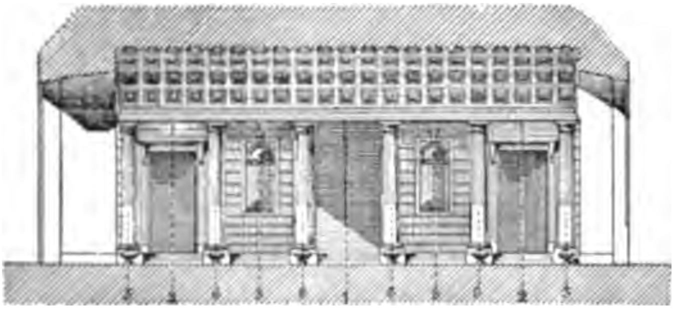


Fig. 8. Hotel des Monnaies, Longitudinal Section of Vestibule.
Section on ZZ.

Now let us consider the sections, taking the same example that we have just considered. The student will easily see that the architect cannot study his composition thoroughly without the aid of numerous sections. Two sections, however, are especially necessary, those following the principal transverse and longitudinal axes of symmetry. If the student wishes to draw both of them, he should decide first which one of the two controls the other. See Figs. 7 and 8. He will see that in this case it is the transverse section, parallel to the front elevation. The other, the longitudinal section, is chiefly the projection of elements of the other section. Therefore, in this case the drawing should be commenced by laying out the transverse section.

First, place the axes just as has been done in the plan, 1, 2 2, 3 3, 7 7, 8 8. In regard to the profiles or the parts in section, the first thing necessary is to locate the heights of the essential parts, taking for the first level the main floor A A, next drawing the upper line of the capitals of the columns B B, then the centers of the vaults C D.

Starting with these principal lines, draw in the details, as for example, the heights of the bases in relation to the floor A A. The capitals and heights of the architraves will be located in relation to the line B B. It is evident that if all the measurements were taken from the level of the main floor A A, the least inexactness would affect the capitals, while if the total height of the column A B is once determined, no mistake can be made in the height of the base and that of the capital, and even admitting a slight inexactness, it will be inappreciable on the total height of the shaft of the column.

In all which has preceded, the drawing has been laid out along the lines of the axes. But besides these are some conventional methods by which the drawing of profiles in section or in elevation can be facilitated. Let us take for example a fragment of the Doric order—one from the Parthenon, Fig. 9. To reproduce this drawing one should measure the different projections by referring them to one single vertical line. In this case the axis of the column would not furnish a convenient axis for measurement, as with exception of the column, it determines nothing. It is best to proceed just as in measuring an existing order, that is, by dropping a plumb line from the overhanging cornice and measuring the distance from that plumb line to the various members. But this vertical line from the outer member of the cornice will be only useful for laying out the profile and in locating the axis of the column; axes should be drawn in every other possible case. For instance, place the column on the axis A; the triglyphs, on B; the metopes, on C; the head of the lion, on D, etc. To obtain the heights draw the principal divisions in first; the total height of the capital, the total height of the architrave, the complete frieze, the complete cornice; then draw in each detail in height within these first divisions.

The channels of the triglyphs, the guttae, etc., are all drawn in on their own axes. As for the channels of the column, these can only be drawn by projecting them. Do not copy them from the drawing, but draw out a plan, dividing the circumference into twenty parts or whatever number the design calls for, and project these divisions up to the elevation.

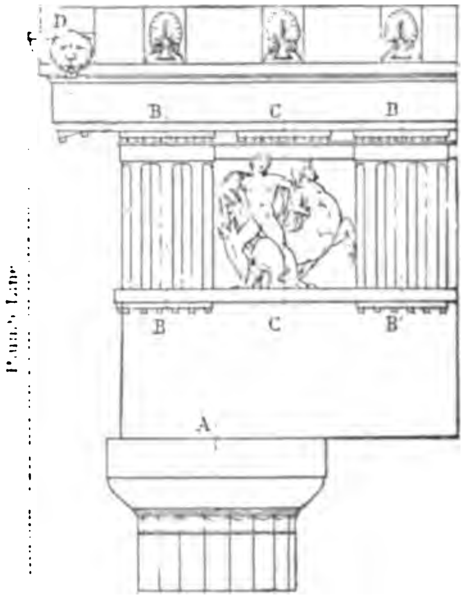


Fig. 9. Capital and Entablature from the Parthenon.

Study the model carefully before copying it; thus, in this example a close examination will show that the architrave is slightly sloping while the frieze is not. If the student has the opportunity to see mouldings similar to those which he is drawing, he should study them carefully. It cannot be too often repeated that architectural drawing should not confine itself to exercise for the hand; there should be the opportunity for real study of whatever is drawn.

Limiting Lines. In geometry, we have learned what the *abscissa* and the *ordinate* are; *i.e.*, the elements of reference by which a point is referred to a system of fixed rectilinear co-ordinate axes. For every part of a design of which the elements are not geometrical lines, such as a right line or circle, the method of abscissa and ordinate is used, as in laying out profiles of mouldings or curved ornaments such as eggs in the egg and dart motive. Take for example a baluster, Fig. 10; it is evident that it should be drawn in relation to its axis. The student will mark the general divisions, A B the die, B C the base, C D the shaft, D E the capital, after which the secondary lines of the mouldings should be drawn in. Between C and D, however, the profile of the shaft may vary very much and the student will not be able to copy it except by laying off horizontal divisions. For that purpose, draw the limiting lines of its greatest width *m m*, mark its point of application M, and repeat this operation on the drawing. In the same manner lay off the line *n n*, and the point N, which gives the smallest diameter of the shaft, and do not mark these points by a single point with the pencil, but be careful to draw the limiting (in this case vertical) lines at every point, and do not erase them until after you have inked in the drawing. These lines will be a safe guide and will enable one to make an exact and clean drawing.

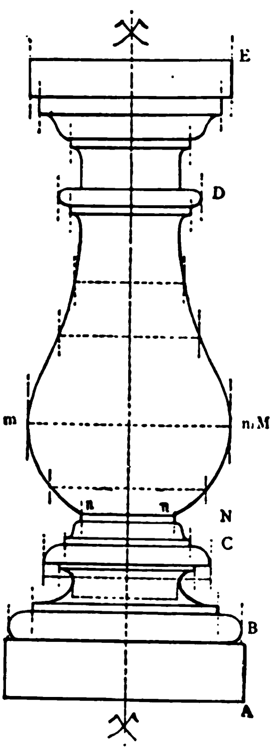
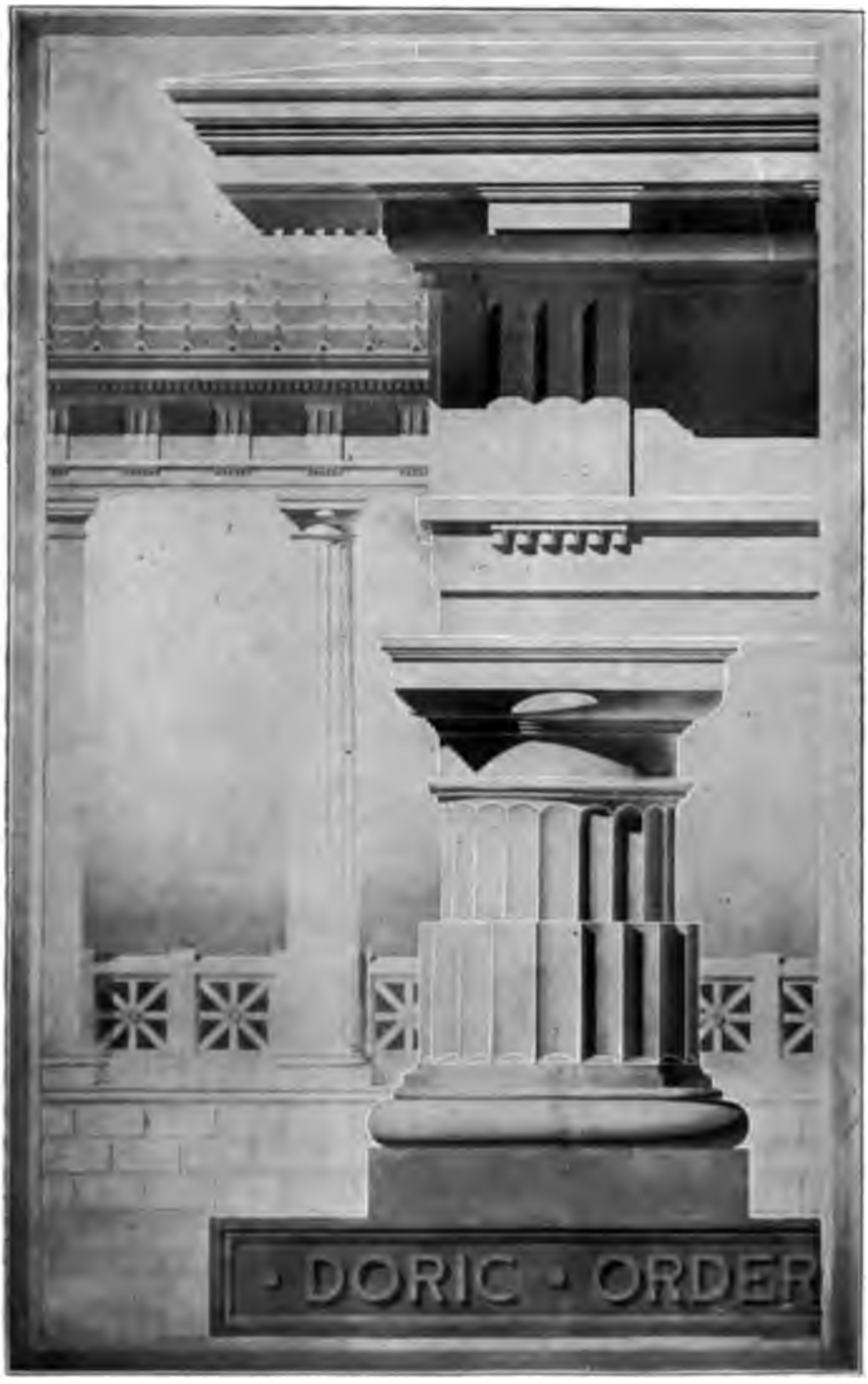


Fig. 10. Baluster.

As another example take the fragment of the cornice with different ornaments, taken from the Temple of Concord, at Rome, Fig. 11. The construction lines marked on the drawing, and which should be kept in pencil until the drawing is completed, show especially well the method previously explained.

Finally, to produce an architectural drawing with precision demands primarily a rational method and methodical habits. The design gains by its facility, but the method can only be a general one In its application, an intelligent draftsman will recognize each time what should be the logical sequence in carrying out the drawing. And still, all of this will be only the mechanism of the design; it is necessary to put into it taste and sentiment. For all of this there is only one precept—it is by practice that one becomes a good workman.

Oblique Projections. It happens often that in an elevation or section architectural motives are represented obliquely in relation to the principal plane of projection. Thus in a circular building a series of similar windows are in elevation at different angles, consequently the widths differ, but the heights do not.



DETAIL OF ROMAN DORIC ORDER

An example of conventional shadows and rendering in wash. Note the French method of rendering the quarter round moulding under cornice and the reflected shadows. See section on "Rendering in Wash" page 33.

Reproduced by Permission of Columbia University

It is necessary to become familiar with these conditions of drawing which occur frequently. It is here above all that geometry will be very useful, for that study includes the planes of projection and planes of development.

While there is some little difficulty, there is also much profit to be gained in projecting an architectural motive at an angle. In order to project a motive at an angle correctly, one must understand the motive thoroughly. An architectural arrangement drawn out in direct elevation only, will not tell the whole story, but if drawn in oblique projection a thorough understanding of the arrangement is gained.

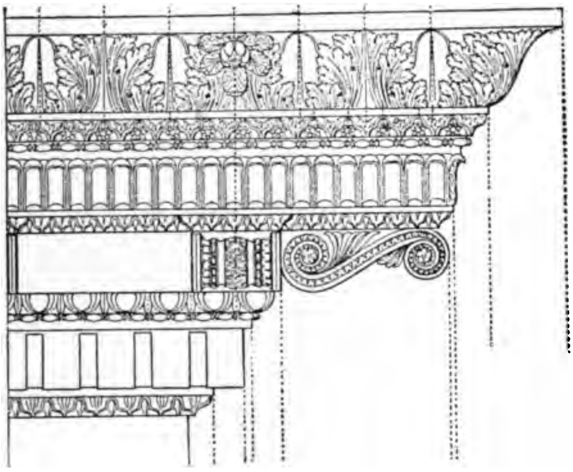


Fig 11. Entablature from the Temple of Concord, Rome.

It is recommended, therefore, as a very useful exercise to draw out in oblique projections, designs that are made in direct elevation; it is a good exercise in design, but above all it is an excellent preparation for architecture, compelling the designer to analyze his model and to see it *as a whole;* to understand its projections and to comprehend the position of the different details. The designer realizes that he is working on the real building rather than in simple imagination, and so will soon see of how much advantage these exercises will be to him.

Consider, for example, two windows, one in direct elevation and the other projected at an angle. It is evident that the direct elevation permits the study of proportions and it is evident also that the oblique projection shows more than the direct elevation of the different parts of the window. In the same manner draw out the development of such parts of buildings as vaultings, circular walls, etc.

All this can be summed up thus: Study architectural drawing as an architect. Become accustomed to see in the drawing the object represented. It is very necessary that the drawing should be nothing more for the designer than a sort of language, and that he should see in reality the thing itself, just as a composer of music, as he puts down on paper the notes of his score, can hear them as though they were being played; just as everyone in reading a book of printed characters never notices the printed letters but feels the emotions that are meant to be conveyed as though the words were spoken.

Modeling an Architectural Drawing. A design is only complete when in addition to the outlines, it is modeled, that is to say when the form is expressed. The most common process for modeling an architectural design is by wash drawing, but the methods of modeling are the same whether done by wash drawing or by rendering with the pen, the pencil, or other processes. It is not possible to say that modeling has absolute rules, or that all methods are good even if the desired effect is obtained; *i.e.*, if the reliefs and the forms are represented in their true relations to one another. There are, however, certain general principles that can be used as a guide in modeling a drawing.

Shadows at 45 Degrees. It is the custom to assume that the light rays fall in a direction, the horizontal and vertical projections of which make an angle of 45 degrees with the line of the ground. The luminous ray itself does not make, in reality, an angle of 45 degrees with the planes of projection. Its direction is that of the diagonal of a cube whose faces are respectively parallel and perpendicular to the planes of projection.

This method has two advantages; the laying out is easier, which it is well to consider, for the drawing of shadows is often a long and complicated process, and in this case the depth of the shadows is equal to the projections. Consequently, the size of the shadows permits anyone to understand, without further drawings, the projection of one architectural body in relation to another, and the relative positions in space of the different surfaces in one body.

The drawing of shadows is often difficult; it is one of the essential parts of descriptive geometry that will also be found in special treatises. As for indicating shadows which cannot be laid out accurately, such as shadows of decorative parts, it is a matter of judgment to determine the amount of projection—a knowledge gained by experience.

Values. After having drawn the shadows, lay over the shadow part a uniform tint. Now the drawing will be seen to be divided into lights and shadows.

As a first principle, it is necessary always to make a distinction between light and shade; shadows will always be modeled, lights will also always be modeled; but it is necessary to be able to distinguish clearly which is light and which is shade in the same drawing, at least where there are large spaces between different planes. The parts having the darkest tint in the light should remain lighter than the lightest reflected lights of the parts in shadow. Besides this, geometrical design, not being able to make use of the illusions of perspective to show distances and projections, has to make use of expressive modeling, since it is *the values* of the tints alone which will indicate the relative distances and projections.

Therefore, in order to bring forward or to set back one plane with relation to another, the only resource will be to tint them differently. Notice what happens in this respect in nature; for instance, an object placed near the eye is modeled very clearly and one at some distance is modeled much less, and one at a great distance or on the horizon, is only a mass without details. So, the nearer the object is, the more it is modeled and the greater are the differences between the shadows and the lights; on the contrary, the further away it is the more the lights and shadows tend to mingle. In the foreground there will be strong shadows and high lights, in the distance dull shadows and softened lights; between these an intermediate proportion of shadows and lights. Therefore, in facade, the planes farthest away from the eye will have the least modeling, while the nearer the plane is to the eye, the more is the modeling accented.

As stated above, in nature every light and every shade is modeled and graded; the shadows are more noticeably graded than the lights. The reason for this gradation of shadows is the indirect lighting thrown back on the shaded objects by neighboring lighted objects, and this is called reflected light.

Take for example a cylindrical body like the shaft of a column. It is easy to distinguish on this cylinder cast shadows and shades. The cast shadows are those which result from the interception by another solid, of luminous rays which without it would have lighted the cylinder. Shades result from the absence of light on the part of the cylinder which by its position cannot receive light rays. Naturally shadows are less affected by reflected light than shades. The reflection of light or the throwing back of light which creates the reflected light comes from lighted bodies, which in theory may be considered as secondary sources of rays of light of which the resultant will be in the direction opposite to the light. That is, since the lighting is in a direction of 45 degrees from above down, and conventionally from left to right, the direction of the reflected light is in the direction of a diagonal from the lower right front corner to the upper rear left corner.

This conventional theory is to be followed as the rule for modeling. Commence with the lights, or where the gradations are more easily comprehended. Take a solid of white stone, for example, a sphere. It is easy to comprehend that the strongest lighting will be at the point of intersection of the surface of the sphere with the luminous ray which prolonged will pass through the center. Then, around this pole of light, the angle of the luminous ray with the surface will be diminishing constantly following parallel zones, having the luminous point for the pole, until it becomes tangent to the sphere following a great circle whose luminous point is also the pole and which will be the line separating the shade from the light. In other words, the light will diminish from the pole to this equator.

In the shadow it will be just the opposite; the greatest reflection will be at the other extreme of the ray prolonged to pass through the luminous point and the center of the sphere, the shadow will increase in intensity from the pole of reflected light to the separating circle of shade and light.

But if any body casts a shadow on the lighted part of the sphere, its shadow will be much less affected by reflected light and consequently will be more intense than the shade itself.

From this follow two rules for modeling: (1) A shadow cannot be cast on a body unless this body is in the light and some other body is casting the shadow; (2) The value of the intensity, *i.e.*, the degree of darkness, of the cast shadow at any point is in direct ratio to the strength of light on that point.

The application of these rules can be illustrated on a geometric body, for example, the capital of a Doric column and its architrave,

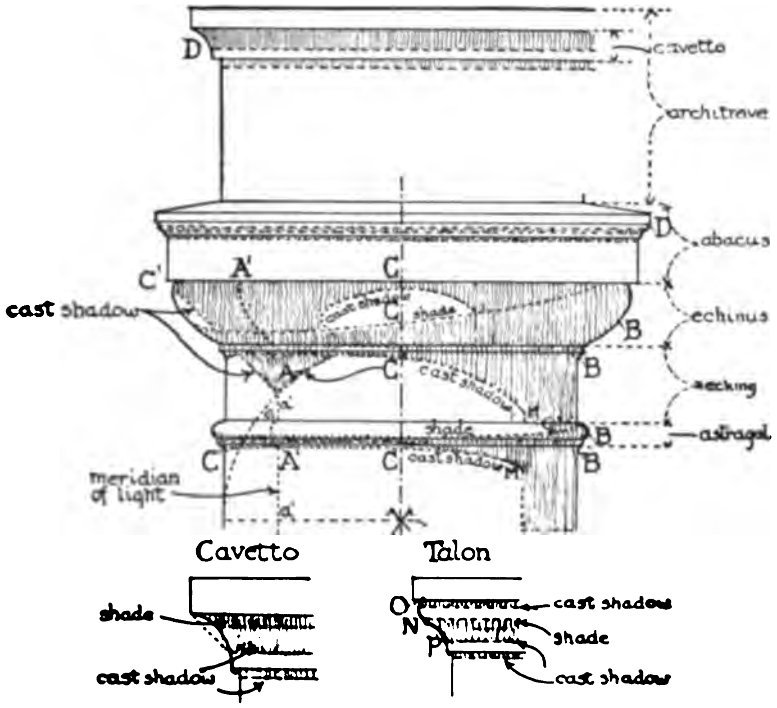


Fig. 12. Shadows on Capital of Doric Column.

Fig. 12. The shadows should be drawn out and a light shadow tint laid over them. Now let us consider where the most intense shadows will be. Evidently at A, where the shadow is determined by a ray normal to the cylindrical surface of a column, and the parts A' A', of the cast shadows which meet the surface of revolution following its meridian of light. The clearest reflected shadows cannot be seen in the drawing as they will be found at the back of the projection on the meridian opposite the point A. But among the parts seen on the drawing the most reflected light will be at the point B B, doubly lighted by its position on plan and by the form of the moulding.

Between these extremes the parts C C will have intermediate values, whether shades themselves or cast shadows. Also, observe that the values of the light at contour C′ are symmetrical with the values of the light of contour C. There will be, therefore, a symmetry of modeling, in relation to an axis of the most intense lighting on the column of the luminous part and of the intensity of the shadows; this axis will be on meridian A. As for the mouldings which are straight in plan like D D, their general value will be analogous to the intermediate value C C.

Passing to the lights, we see that the point most lighted will be the point *a*, and finally the generatrix *a′ a′;* and the light will become more and more gray up to the tangent M M. But along the astragal the light will extend in almost uniform intensity, for it will strike more normally than on the cylinder. As for the straight parts, the abacus, the architrave and fillets, they will receive less light than the cylinder at *a′ a′* and approximately the same as at C C; the sloping part of the abacus will naturally have a more intense light. Otherwise each one of the plain surfaces, in shadow or light, will be graded from the upper part down, because the nearer the surface is to the ground, the more reflected light it receives. For each detail use the same reasoning. Thus, for the cavetto, there is a cast shadow in the lower part, but the portion above the tangent is in shade. The shadow is modelled by continuous grading from darkest at the lower part to the lightest in the upper part; the talon will have cast shadows at O and P, the portions at N being in shade, hence O and P are the darkest parts while N is the lightest.

Another element comes into the modeling; *i.e.*, the openings. An opening is always darker than the simple shadows, for there is almost no reflection that comes in the opening to lighten the shadow. Such are the door and window openings of a facade. The parts in shadow, which are less accessible to the reflections, will be darker than the other parts. For instance, the openings between the dentils, the spaces between the consoles, etc., will be darker than the face of the dentils or consoles and may be as dark as the general shade of the openings. The modeling should be such that the parts which are by themselves in reality, will appear so on the drawing. It is not necessary to exaggerate; the modeling should remain simple.

Lacking good models, it is always easy to get good photographs of good wash drawings; for example, a large number of "Envois de Rome", or drawings made by students in Rome, have been photographed and published. These are models which cannot mislead one.

RENDERING IN WASH.

All studies and completed exhibition drawings in the architectural schools are tinted in India ink or water-color. This is done to show the shadows, and to indicate the relative position of the different planes, and is the method of representation in common use in architects' offices, especially in the presentation of competition drawings.

MATERIALS.

Chinese, Japanese or India inks are used for rendering, on account of their clear quality and rich neutral tone. The ink comes in sticks, Fig. 13, and it is ground in a slate slab provided with a piece of glass for a cover. See Fig. 14.

Fig. 13. India Ink.

There are various kinds of brushes. Camel's hair brushes are the cheapest and are useful for rough work. Sable brushes, Fig. 15, are two to three times as expensive as the camel's hair ones on account of the material, but are also very much better. The sable brushes have a spring to them not to be found in the camel's hair brush, and they come to a finer, firmer point. Chinese and

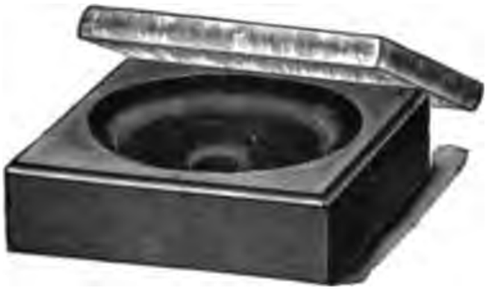


Fig. 14. Ink Slab.

Japanese brushes are used a good deal of late, as they are cheaper than the sable brushes and have some spring to them. A stippling brush is one with a square end, used mostly in china painting. A bristle brush is a stiff brush used in oil painting; on account of its stiffness it is used for taking out hard edges, as described later on. Fig. 16 shows a nest of porcelain cabinet saucers.

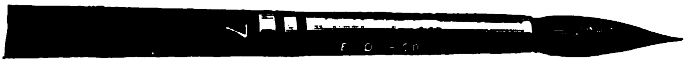


Fig. 15. Sable Brush.

Besides these materials the student should provide himself with a large and a small soft sponge, and large blotters, which will sop up water readily. Whatman's "cold pressed" paper is the best paper to use for rendering in India ink.

METHOD OF PROCEDURE.

Stretching Paper. All drawings on which washes are to be laid should be stretched, as described in the Mechanical Drawing, Part 1.

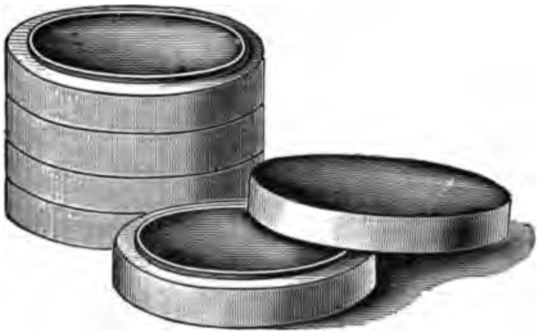


Fig. 16. Nest of Saucers.

Inking the Drawing. The lines should be drawn with ground India ink, the ink being as black as possible without being too thick to flow. Ornament should be inked in with lighter lines than the vertical and horizontal lines. This accents the structural lines. Very often the outline of the ornament is drawn in a heavier line than the remainder. The width of the line should vary with the scale of the drawing, the larger and bolder the drawing the wider the line.

India ink evaporates very rapidly. It should be kept covered and changed several times a day, especially in summer. After the drawing is inked it should be washed to remove the surplus ink, otherwise when the tint is applied the ink will spread. This is best done by placing it under a faucet and rubbing it *very* lightly with a soft sponge. If the inking has been properly done the lines will now have the appearance of a firm pencil line of a soft neutral color forming a harmonious background for the tint. The shadows should then be cast and drawn in with a hard pencil in *faint* lines.

Preparing the Tint. For large washes India ink should be freshly ground in a clean saucer each time it is required. In no case use the prepared India ink which comes in bottles, as this is full of sediment which settles out in streaks on the drawing. Always use the stick ink.

Rub the ink in the saucer until it is *very* black; then let it stand, keeping the saucer covered. This allows the sediment, which is so fatal to a clear wash, to settle. After it has settled take the ink from the top with a brush without disturbing the bottom. Put this ink into another saucer and dilute it with the necessary amount of water. Never use the ink in the saucer in which it was originally ground. In dipping the brush into the second saucer it is well to take this ink also from the surface and thus avoid stirring any sediment which may still remain in the ink. In other words, the sediment which is found in even the most carefully ground ink should never be used for washes, otherwise streaks and spots may show in the washes.

Where only a small surface is to be rendered the tint can be mixed on a piece of paper in the same manner in which it is mixed in the saucer. Thus various shades can be obtained more quickly and experiments made more easily. Skill in laying washes is only acquired by practice. However, some instruction is necessary. If, after all possible care has been taken during the drawing, such as placing paper under the hand to keep the paper from getting greasy and keeping the drawing covered to protect it from the dust, the paper has nevertheless become soiled, it should be cleaned by giving it a light sponging with a very soft sponge and perfectly clean water. Touch the surface lightly, sop on the water liberally, and dry it off immediately with a sponge or blotter *without rubbing*. Before washing, the paper should be cleaned by rubbing it *very* lightly with a soft rubber. Especial care must be taken not to injure the surface of the paper by rubbing too hard.

It may seem that all this care is unnecessary, but it is only by observing this extreme care that the skilled draftsman obtains the transparent wash and the beautiful, even, clear tints free from all streaks, which give so much charm to an India ink rendering.

Handling the Brush. Skill in handling the brush is acquired only by constant practice. The brush demands great lightness of hand. The right arm should never support the body. The arm should not rest on the drawing; only the little finger of the right hand should come in contact with the paper. The brush should be held somewhat like a pencil between the thumb and index finger, and the little finger should be very free in its movements. Touch the paper only with the point of the brush.

The brush should be well filled with the tint and care should be taken that there is practically the same amount of tint in the brush at all times. If this is not done, for example, if the brush is allowed to get too dry, one part of the wash will dry faster than the other and streaks will result.

If the brush should be too wet, the surplus moisture can be removed by touching it to blotting paper.

If the paper is too wet the surplus tint can be removed by drying the brush on blotting paper and applying it to the surplus tint which will then be rapidly absorbed by the brush. Great care must be taken not to remove too much of the tint; otherwise it will dry too fast and leave a streak.

Laying Washes. There are two kinds of washes; the clear washes used in rendering shadows, window openings, etc., and the washes in which the color is allowed to settle, the latter being used to render the grounds surrounding a building. When laying clear washes it is better to tip the board slightly so that the washes may flow slowly in the direction in which they are being carried. If the board is placed flat there is danger of the wash running back over the part that is already dry and thus forming a streak.

The edge of the wash should always be kept wet, for if it begins to dry a streak will surely follow. The tint should be carried down evenly across the board, moving the brush rapidly from side to side so that one side does not advance faster than the other. Carry the tint down about an inch at a time, the amount depending upon the size of the brush and of the surface rendered. Always go over the previous half inch at every new advance, taking care not to touch any part that has already dried. In this way the tint will dry gradually, parallel to the work. Carry the sides of the tint forward a little more slowly than the center. This will make the tint run towards the center and help to avoid the lines or streaks due to uneven drying.

The tint should be carried forward in such a way that the paper will be thoroughly and evenly wet. In fact, it is a very good plan to dampen the entire drawing with a soft sponge before beginning to lay a wash. This dampening should be carried well beyond the edges of the drawing so as to prevent the color from spreading to the drier and more absorbent parts of the paper. Always remove the pool of tint which remains at the bottom of a wash in the manner described under "Handling the Brush." If allowed to remain it will dry more slowly than the rest of the drawing and a streak will show.

The drawing board should be left inclined until the wash is dry. Never lay one wash over another before the previous one is absolutely dry.

In laying washes which grade gradually, either from dark to light or light to dark, grade the tint by the addition of water or color each time that an advance is made, and be careful that these additions are such that the change in color is made evenly.

It is very difficult to lay an evenly graded dark tint with one wash only. It is usually better to lay a light flat wash or a light graded wash to serve for a background on which to lay the dark graded wash. By a flat wash is meant a wash which is the same tone or color throughout; that is, a wash that is not graded. See opening in Doric Doorway, Fig. 138, Vol. VIII.

Water has to be added constantly in grading. Where there is a series of graded washes, as in successive window openings, it is better to have two or three saucers containing tints of different strength and carry each tint for the same distance in each window so that the gradation of color may be the same. In grading in this way it is necessary to carry each new wash well back over the old one so the point where one tint ends and another begins may not show.

Sometimes gradations are obtained by laying successive flat washes, each wash beginning a little lower than the previous one. In this way the rendered surface will begin with one flat tint and end with a number of tints, one on top of the other. This is called the French method and is done by drawing *very* faint parallel lines at close intervals to mark the limit of each wash. A very light wash is then put over the whole surface, and this is followed with successive washes, each starting from the next lower line. This method is especially good for rendering narrow, long, horizontal graded washes. See rendering of mouldings opposite page 42. Note particularly the application of this method on the crown moulding, and practically all the curved mouldings.

Avoid laying too many washes in the same place, as the continuous wetting and rubbing which the paper gets from the brush is liable to injure the surface.

If the tints are too dark, a soft sponge can be used to lighten them or to take out hard or dark border lines ; but a large brush about two inches wide is still better for this purpose. If it is necessary to use a sponge, use it with a great deal of water, rub *very* lightly and very patiently. The water should be kept *very* clean, and the surrounding parts should be thoroughly wet before wetting the tinted part, otherwise the tint may spread over the other parts of the drawing. After using the sponge, dry the paper carefully with a clean blotter. Another and better way is to place the whole drawing under the faucet, turn on the water and use the sponge or brush, as already described, on the parts to be lightened.

To make light places darker, use the point of a brush, applying the tint in small dots. Be careful not to begin with too dark a tint. This process is called stippling, and it must be done very gradually and very carefully.

Do not forget that the first quality of a wash is crispness. It is necessary to draw with the same precision with a brush as with a pencil. When the drawing is finished it should be allowed to dry thoroughly before it is cut from the drawing board.

Rendering Elevations. The object of rendering a drawing is to explain the building. Those parts of the building nearest to the spectator should show the greatest contrast in light and dark, for in nature, as an object recedes from the eye, the contrast becomes feebler and feebler and finally vanishes in a monotone. Every elevation shows the horizontal and vertical dimensions of a building, or details of a building, but in a line drawing the projections of the different parts when in direct front elevation are not shown ; and it is to indicate these projections that the shadows are cast and the drawing is rendered. The appearance of a building or any details of a building will be clearly shown by the shadows in their different values of light and dark. See Figs. 128 and 129, Vol. VIII. The windows and other openings of a building should be colored dark, but not black—although this is sometimes required in competition drawings—and varying lighter tints should be used to indicate the color of the material in the roof and walls, the difference in the color intensity indicating the varying distances from the spectator. Note in Fig. 107, Vol. VIII, the comparative values of rendering in roof and shadows on roof; also portions of order in light, portions in shadow, and background of column. This method of drawing is frequently carried to an elaborate extent by showing high lights, reflected shadows, etc., and an elevation can thus be made to show almost as much of the character of the proposed building as would be shown by a perspective view or by a photograph of the completed structure. See opposite page 11, "Fragments from Roman Temple at Cori." Study the different tone values of the various objects in the foreground and in the background, and note the perspective effect of the background.

It is a good plan, before starting to render a drawing, to make a small pencil sketch to determine the tone values which the various surfaces should have, so that they will assume their proper relative positions in the picture.

Drawings of this kind are much superior to any others as a means of studying the probable effect of the building to be constructed, as they show the character of the building and, at the same time, dimensions can be figured directly on the drawing. It is difficult and unusual to give measurements on a perspective drawing.

Rendering Sections and Plans. Sections are frequently rendered in the same manner as elevations to show the interior of buildings. The shadows are cast in such a way that they show the dimensions and shapes of the rooms. The parts actually in section are outlined with a somewhat heavier line and tinted with a light tint. The surfaces are modeled just as they are in the elevations. See illustration opposite page 43.

Plans are rendered to show the character of the different rooms by tinting the mosaic, furniture, surrounding grounds, trees, walks, etc. The shadows of walls, statuary, columns and furniture are often cast, so that the completed rendered plan is an architectural composition which tells more than any other drawing the character of the finished building.

The interior of the building and all covered porticoes are left much lighter than the surrounding grounds because the building is the most important portion of a drawing and should, therefore, receive the first attention of the spectator. The sharp contrast of the black and white of the plan to the surroundings brings about the desired effect. The mosaic, furniture, etc., should be put in in very light tints in order to avoid giving the plan a spotty look. The walls in the plan should be tinted dark or blacked in so that they will stand out clearly. See Fig. 17.

Graded Tints. One rule in laying all tints should be strictly followed: *Grade every wash.* A careful study of the actual shadows on buildings will show that each shadow varies slightly in degree of darkness; that is, shows a gradation. The lower parts of window openings are, as a rule, lighter than the upper parts. Therefore, the washes or tints should grade from dark at the top of the door or window openings to light at the bottom. Furthermore, it will be found that the reflection from the ground lights up shadows cast on the building, so that shadows which are dark at the top become almost as light as the rest of the building at its base.

Windows and doors are voids in the facade of a building, and they have a greater value in the composition of a design than shadows or ornaments in general. This character should be carefully shown in the rendering; and to that end the grading should never show such violent contrasts as to distract the eye from the design as a whole, and thus destroy the unity of the design and the true mass of the openings. Many good designs are greatly injured in the rendering by the violent contrast in the grading of the openings from dark to light.

In the shadow itself it will be found that detail is accented or

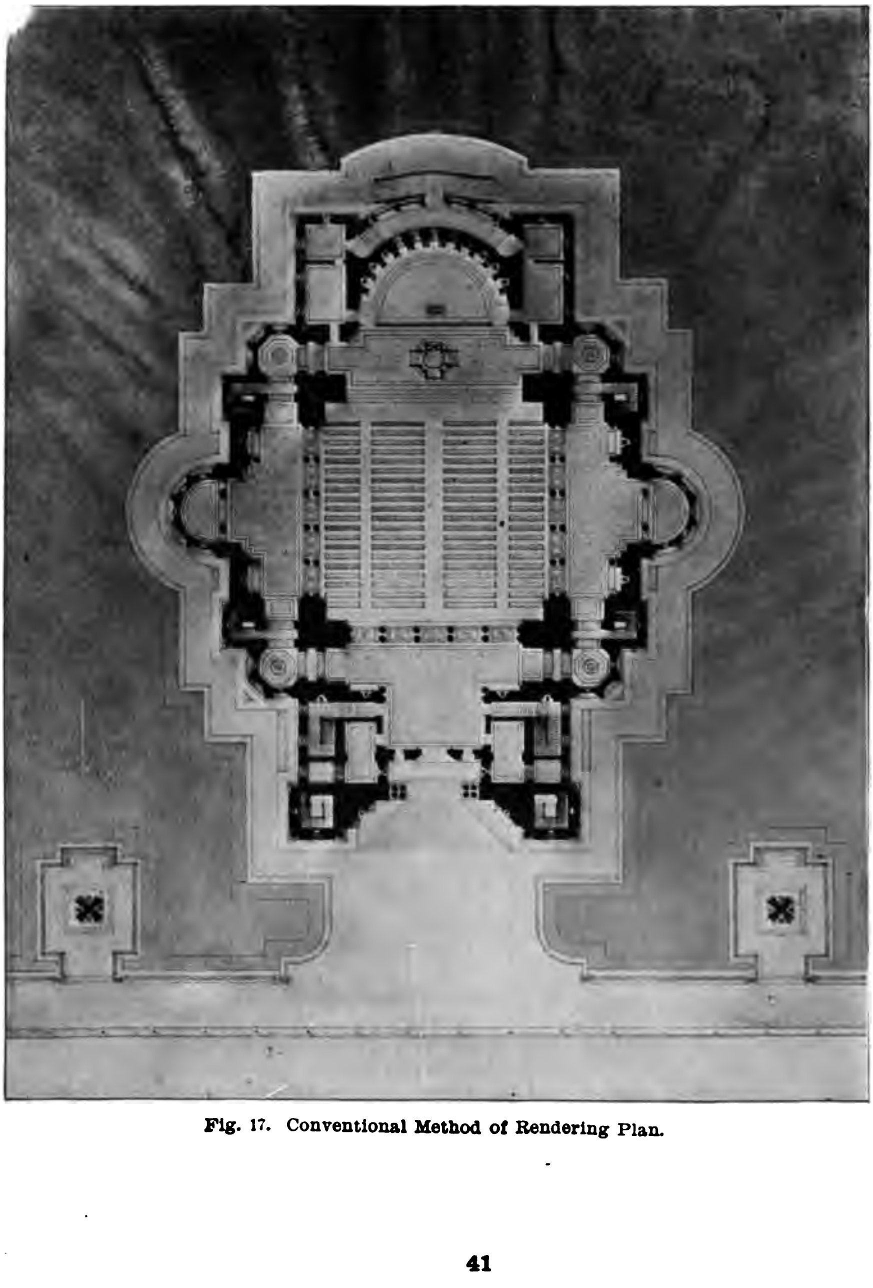


Fig. 17. Conventional Method of Rendering Plan.

brought out by reflected shadows. These shadows are in a direction opposite to the shadows cast by the sun. If the light is assumed to come in the conventional way, namely at an angle of forty-five degrees from the upper front left corner to the lower back right corner, the reflected light may be assumed to be at an angle of forty-five degrees from the lower right front corner to the upper left rear corner, and the reflected shadows will accordingly be cast in this direction. See Greek Doric Order, Fig. 107, Vol. VIII.

If these are worked up in their correct relation to one another the character of the details will be well expressed.

Distinction Between Different Planes. The different planes of a building which project one in front of the other are distinguished from each other in the following manner:

The parts toward the front have a warm color, the portions receiving direct light have a tone over them indicating the material, the shadows are strong and bold, and the reflected shadows are more or less pronounced. The parts toward the rear, on the other hand, have no such strong contrasts of light and dark. The light parts are often left very light and the shadows put in even tones. The further the object is from the spectator the less pronounced will be the reflected lights and shadows. Note the grading on the steps in Fig. 129, Vol. VIII, and study the frontispiece opposite page 11 as an illustration of this point.

In rendering, a difference should be made for different materials. Note the difference between the stone and the metal work in illustration opposite page 53.

A FEW WATER COLOR HINTS FOR DRAFTSMEN.

Many draftsmen who are strong in drawing, are very weak in color work. The reason for this is, in most cases, that the colors are not fresh, that the brush is too dry, and that the color values are not correct. *Fresh* crisp color is most important. To get this it is necessary to start with a clean color box, clean brushes, and clean paints. The colors should be moist and not dry and hard.

Tube and Pan Colors. After having acquired some facility in the use of colors, tube colors are the best to use, although they are somewhat more wasteful than pan colors. They are less likely to harden and dry up and are not more expensive. The

colors in the tubes can be squeezed out on the palette as needed, and if this is done fresh bright effects are obtained. For the beginner, however, pan colors are recommended, as they are more easy to handle. Fig. 18 shows a japanned tin box for pan colors, Fig. 19 shows a pan color, and Fig. 20 a tube color.

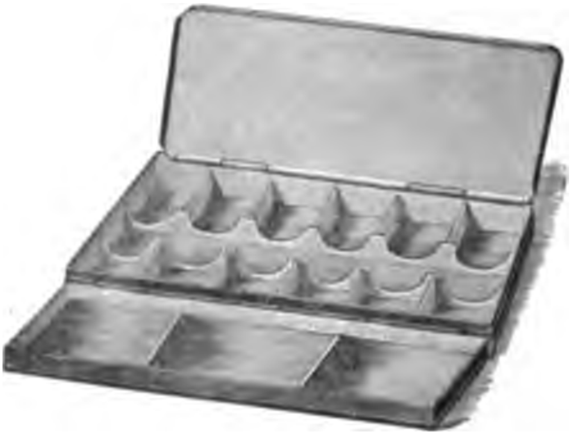


Fig. 18. Box for Pan Colors.

LIST OF COLORS: The following list of colors will make a very good palette:

Cadmium
Indian Yellow
Lemon Yellow
Gallstone
Yellow Ochre
Orange Vermilion
Carmine
Light Red
Burnt Sienna
Warm Sepia
Cobalt Blue
New Blue
Prussian Blue
Paine's Gray
Emerald Green
Hooker's Green
Chinese White

The colors printed in italics are clear colors which will give clear even washes. The others will settle out, the color settling into the pores of the paper producing many small spots. This effect is often desirable giving a texture which cannot be obtained with the clear colors.

Fig. 19. Pan Color.

Fig. 20. Tube Color.

For use in the offices, India ink, Chinese white, gallstone, carmine and indigo will be found very convenient. The latter three are convenient forms of the three primary colors to use with India ink in rendering. Many draftsmen use these alone.

Manipulation. The washed-out look of many of the color sketches seen in architectural exhibitions is very noticeable. The sketches lack strength and crispness.

Color properly applied should be put on boldly in broad simple washes without fear of too much color. Remember that colors when dry are much lighter than when in a moist state. Use plenty of clear water in the brush. Do not go over one wash with another before the first is entirely dry. This is particularly true where a deeper tone is to be put over a lighter one. In broad sky washes where there is a great deal of paper to be covered, dampen the surface well first with a small sponge, then with a large brush and bold yet light quick strokes put in the sky.

Brushes and Paper. A small brush with a good point is necessary for "drawing in" and for detail. A bristle brush is very useful to remove color and to soften hard lines. Chinese brushes are very good, as they hold a great deal of color and at the same time have a good point.

If an edge shows a hard line, this can be softened by dipping the bristle brush into clean water and rubbing the point lightly over the edge that is too hard, sopping up the water at frequent intervals with a clean blotter. It is important that plenty of *clean* water should be used and that the water be taken up with a blotter very often.

When a "high light" is lost, and a bristle brush does not take out enough color, the "high light" may be put in with Chinese white, mixing it with a little of the color of the material.

Look at your subject broadly and do not try to put in too many details. Whatman's hot pressed 70- or 90-lb. paper is good to use. The hot pressed paper, which has a smooth surface, takes the color better than the rough surfaced or cold pressed paper, but the cold pressed has more texture and gives better atmospheric effects.

Combination of Color. For the inexperienced a few hints as to what combinations of color to use may be helpful. It must always be remembered that the colors must be clean to get fresh bright effects.

A simple blue sky: Prussian Blue, Antwerp Blue or Cobalt Blue.

Clouds: Light Red. For the distance use lighter tones with the addition of a little Emerald Green or Carmine.

Dark part of clouds: Light Red and New Blue.

Roads and pathways in sunlight: Yellow Ochre and Light Red with a little New Blue to gray it.

Cast shadows: Cobalt and Light Red or Carmine with a little green added.

Grass in sunlight: Lemon Yellow and Emerald or Hooker's Green; or Indian Yellow and Emerald Green.

Grass in shadow: Prussian Blue and Indian Red; or Prussian Blue and Burnt Sienna. Aurora Yellow and Prussian Blue gives a green color similar to Emerald.

For gray roofs in sunlight: Light Red and New Blue.

Primary, Secondary and Complementary Colors. The combination of colors may be learned by means of the diagram, Fig. 21, which will assist the student greatly in his water color work. The three primary colors are yellow, red and blue. The combination of any two of these will give a secondary color--orange, purple or green. Two colors are called complementary colors if the one is composed of two of the primary colors and the other one is the third primary color. Thus, green, composed of the primary colors blue and yellow, has as complementary color the third primary color; *i.e.*, red. Consulting the diagram it will be found that opposite colors are complementary colors; *i.e.*, blue and orange, red and green, yellow and purple. If two complementary colors are put alongside of one another, each color will look brighter alongside the other than if placed by itself; this is due to the law of contrasts. Thus, the same green if placed alongside red, will look greener than when by itself, and the same holds good for the

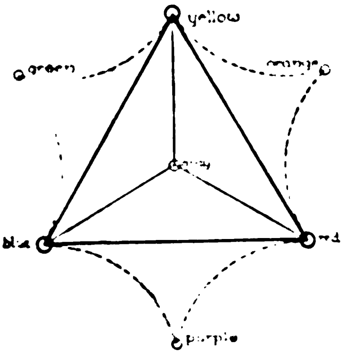


Fig. 21. Diagram of Colors

For use in the offices, India ink, Chinese white, gallstone, carmine and indigo will be found very convenient. The latter three are convenient forms of the three primary colors to use with India ink in rendering. Many draftsmen use these alone.

Manipulation. The washed-out look of many of the color sketches seen in architectural exhibitions is very noticeable. The sketches lack strength and crispness.

Color properly applied should be put on boldly in broad simple washes without fear of too much color. Remember that colors when dry are much lighter than when in a moist state. Use plenty of clear water in the brush. Do not go over one wash with another before the first is entirely dry. This is particularly true where a deeper tone is to be put over a lighter one. In broad sky washes where there is a great deal of paper to be covered, dampen the surface well first with a small sponge, then with a large brush and bold yet light quick strokes put in the sky.

Brushes and Paper. A small brush with a good point is necessary for "drawing in" and for detail. A bristle brush is very useful to remove color and to soften hard lines. Chinese brushes are very good, as they hold a great deal of color and at the same time have a good point.

If an edge shows a hard line, this can be softened by dipping the bristle brush into clean water and rubbing the point lightly over the edge that is too hard, sopping up the water at frequent intervals with a clean blotter. It is important that plenty of *clean* water should be used and that the water be taken up with a blotter very often.

When a "high light" is lost, and a bristle brush does not take out enough color, the "high light" may be put in with Chinese white, mixing it with a little of the color of the material.

Look at your subject broadly and do not try to put in too many details. Whatman's hot pressed 70- or 90-lb. paper is good to use. The hot pressed paper, which has a smooth surface, takes the color better than the rough surfaced or cold pressed paper, but the cold pressed has more texture and gives better atmospheric effects.

Combination of Color. For the inexperienced a few hints as to what combinations of color to use may be helpful. It must always be remembered that the colors must be clean to get fresh bright effects.

A simple blue sky: Prussian Blue, Antwerp Blue or Cobalt Blue.

Clouds: Light Red. For the distance use lighter tones with the addition of a little Emerald Green or Carmine.

Dark part of clouds: Light Red and New Blue.

Roads and pathways in sunlight: Yellow Ochre and Light Red with a little New Blue to gray it.

Cast shadows: Cobalt and Light Red or Carmine with a little green added.

Grass in sunlight: Lemon Yellow and Emerald or Hooker's Green; or Indian Yellow and Emerald Green.

Grass in shadow: Prussian Blue and Indian Red; or Prussian Blue and Burnt Sienna. Aurora Yellow and Prussian Blue gives a green color similar to Emerald.

For gray roofs in sunlight: Light Red and New Blue.

Primary, Secondary and Complementary Colors. The combination of colors may be learned by means of the diagram, Fig. 21, which will assist the student greatly in his water color work. The three primary colors are yellow, red and blue. The combination of any two of these will give a secondary color—orange, purple or green. Two colors are called complementary colors if the one is composed of two of the primary colors and the other one is the third primary color. Thus, green, composed of the primary colors blue and yellow, has as complementary color the third primary color; *i.e.*, red. Consulting the diagram it will be found that opposite colors are complementary colors; *i.e.*, blue and orange, red and green, yellow and purple. If two complementary colors are put alongside of one another, each color will look brighter alongside the other than if placed by itself; this is due to the law of contrasts. Thus, the same green if placed alongside red, will look greener than when by itself, and the same holds good for the

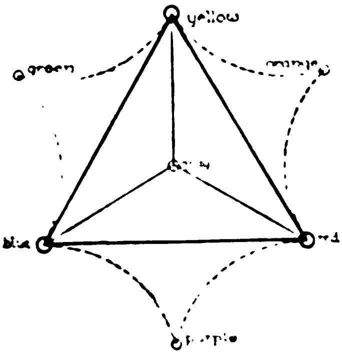


Fig. 21. Diagram of Colors

red. If complementary colors are mixed together you get a softer color, a gray and sometimes muddy effect. If blue, red and yellow are mixed together in the right proportion a soft gray is obtained

Water Color Rendering. Where colors are used for architectural drawings they should be mixed fresh, if clear tints are wanted, but in places where it is desired to have certain effects obtained by allowing color to settle, tints that have stood some time may be used. Especially is this true for plans, where the color is allowed to settle in putting in grass, trees, statues, etc. When it is desired to let the color settle it is better to leave the board flat and carry the color along with the brush, leaving it until it is dry. Some draftsmen keep the board level for all their work.

Sketch elevations in pencil may be inked in or may be rendered directly in water color, the shadows being cast and various colored tints laid on to show the different materials, shadows, window openings, etc.

Sketches rendered in sepia only are very effective, putting in the lines with the pen, and rendering with light sepia washes. Elevations are usually most effective when the shadows are put in by washes that grade quickly from dark to light, brilliancy is thus obtained. It is astonishing what effects can be obtained with very faint washes. This applies especially to small scale drawings. The larger the scale of the building or detail, the stronger should be the coloring and values of light and dark.

When sections are colored the parts actually in section are outlined with a strong red line and tinted a very light pink. The colors on the wall are merely suggested.

On the plans the mosaic, furniture, etc., is often shown in a light pink. Where a statue has a prominent place it is put in in strong vermilion. Attention is called here to the fact that lettering on a plan counts as mosaic, and should be done in such a way that it will help the effect sought for, a very important point to remember in competition drawings.

The important thing to remember in rendering is to get the correct relative value of lights and darks. To do this it is necessary to have clearly in mind what the important features to be brought out are and what is the most direct way of accomplishing this; in other words, the aim should be to make as harmonious a composition as taste, talent and thought can produce.

Water Color Sketching. Nothing is more useful to an architectural draftsman than out-of-door sketching in colors. A water color block should be his constant companion on his Saturday half holidays, and, if possible, he should join some sketching class.

The sketches in water color may be taken from natural scenery, but the student should also make studies and color sketches from color decorations of exterior and interior of buildings.

Do not indicate too much in water color sketching, search for the big masses in shape and color values and put them in direct and simple.

A draftsman who gives his leisure time to water color sketching in summer, and to evening classes in drawing from the antique and from life in winter, will have as good a training as could be wished for in this part of his architectural career.

PRELIMINARY STUDIES IN ARCHITECTURAL DESIGN.

Methods of Study. Different designers work up their drawings in individual ways. Good results are, as a rule, accomplished by getting ideas on paper, comparing and working up the best, and combining different features from the different sketches. Some men of the highest ability prefer to work in this way. Others work up the ideas in their minds before drawing them on paper, often not changing a line once it is put on paper. The latter proceeding is dangerous, as it tends to make the designer satisfied with the first idea that comes to his mind, and makes him unwilling to search for other ideas; he is liable to become narrow and careless.

Putting Ideas on Paper. The problem which the architect has to work out is to make the building of a form and of dimensions best suited to the demands of the client, so that all the parts are in good proportion and in harmony with each other. Much detail in former times was studied on the building in course of construction, but now everything has to be prepared beforehand, and the smallest details foreseen before the building is commenced. The preliminary sketches are generally made on a small scale, one-eighth inch, one-sixteenth inch, or one-thirty-second inch to the foot, worked up from rough thumb-nail sketches often not drawn to scale. Some designers will work up their schemes upon the back of an envelope, and these can be brought into scale in the same proportion in which they are sketched out by means of the proportional dividers.

Architectural work is half way between mechanical drawing and so-called freehand drawing, permitting more freehand work than an engineer would consider proper, and demanding more line drawing than an artist would think of employing.

The most successful architectural design generally comes from numerous freehand sketches, as well as accurate studies, frequent erasing and changing on the original drawing, placing studies side by side and comparing them, until a satisfactory solution is found. It is only by continued practice that freedom of expression is obtained, and without this faculty, the best ideas are useless. The well-equipped architect carries a soft pencil, and sketches as rapidly as possible every new impression on paper.

Use of Tracing Paper. When the plan has been well studied, a sketch of the elevation and section should be made as a check on the "scale" of the plan. Tracing paper should be constantly used, both in making rough studies over the drawing and in making accurate line-drawings for comparison of the different schemes. These drawings on tracing paper as studies in proportion, should be as accurate as the finished drawing, though, of course, no care is necessary in giving them a finished appearance, and the straight lines may run across intersections, and erasures and changes may be made freely.

METHOD OF STARTING A PROBLEM AT THE ÉCOLE DES BEAUX ARTS, PARIS.

At the School of Fine Arts, in Paris, when a problem is given to the students, they are obliged to work one day by themselves getting out the scheme of the building. Each student then takes a tracing of his "sketch," leaving the original at the school. In his own "atelier" or drafting room, he works up the "sketch" with the criticism of his own professor and fellow students. At the end of four or six weeks the finished drawings are sent to the school to be exhibited and prizes or mentions awarded by the jury selected by the school. The preliminary work of the "sketch" is very similar to actual practice, because an architect is often obliged, in a very short time, to get out preliminary sketches for a client, and these having been accepted, it is his duty to carry them out with as little change as possible, excepting to perfect the proportions and details.

Sketch Plans. The plans, even in the studies, should have the walls colored in with any appropriate color, such as dark gray, as otherwise it is very difficult to see on paper the proportion of the spaces, the ease of circulation, and the general character of the whole in mass and in detail.

Sketch Elevations. After the plans have been thoroughly studied the elevations may be worked up, studying the architectural style and general character of the exterior in relation to the plan. These drawings should be studied over and over again on tracing paper, casting the shadows so that the projection of cornices and sizes of window openings may be seen; at this time also details of a larger scale may be studied in sketch form.

On the elevations or in perspective, the jointing of the stone, brick or terra cotta, may be drawn and this will give a surface texture that may save further rendering.

Perspective Studies. For all smaller buildings, such as cottages, farm buildings and small public buildings, requiring a picturesque treatment, such as a broken roof line, it is better, instead of spending much time on elevations with the shadows cast, to draw almost at the start, a perspective from the most important point of view, and make rapid sketch perspectives from several different points of view.

Perspective Drawing. A perspective should be made of every building designed, primarily in order that the designer may see how planes at right angles—for instance, the side and front elevations—come together, and also how roof lines will look from the customary point of sight. This is especially necessary in buildings of a picturesque character. A perspective is also generally demanded for exhibition purposes, so that clients may gain a better idea of the appearance of the proposed building.

Perspective sketches to explain certain points in the drawings are of great value. Very difficult detail drawings may have sketched on them the details in perspective from different points of view. These sketches will explain more clearly than many careful drawings how certain parts come together. Such drawings are very welcome in the workshop and on the building in course of construction.

EXHIBITION DRAWINGS.

Exhibition or show drawings consist of plans, elevations, sections, and perspectives; the drawings are in line, pencil, pen and ink, or color; and all are carefully drawn and mounted, to show the scheme for the proposed building. These may be the preliminary sketches of an architect regularly employed, or they may be competition drawings.

The plan is blacked-in, the furniture delicately tinted, and the surroundings rendered in monotone or color. On the elevations the windows are colored in with graded washes. Every shadow is cast and tinted in; if in color, the different materials are indicated by different colors. In the sections shadows are cast on the section and the color schemes of the various apartments are suggested.

The general idea of the proposed building is best presented to the public by a perspective view, rendered in pencil, pen and ink or color. The perspective is generally laid out in the architect's office and then it is sent to a professional artist for completion.

SKETCHING.

We have considered drawings made on a drawing board with T-square and triangles. There is another way of drawing, that is, by sketching.

The sketch is the most rapid means of progressing in the art of designing. In sketching an object one examines it more closely than one otherwise would. Not only is it necessary to understand a composition, to distinguish its separate parts, but it is necessary to fix the relation of these parts and to study carefully the proportions. The eye alone is the real instrument for measurement and guide for proportion, and the sketch is the means for training the eye. Practice alone will give facility in sketching.

Do not make sketches primarily in order to collect material, but make them in order *to learn how to see.* Sketch books may be kept as souvenirs, but the profit from them will be more in the instruction gained while making the sketch than in the sketches themselves. Through abundant sketching a freedom in the expression of ideas is also gained.

The point to keep in view in sketching is to show the character of the subject attempted. The exact dimensions one can get only with the tape-line, but the most carefully measured drawings often fail to show much character. A photograph is liable to represent a subject other than as the eye and hand see it. But if the effect of the subject, the impression of the beholder, can be reproduced in the sketch, something has been obtained which the tape and the camera cannot hope to accomplish.

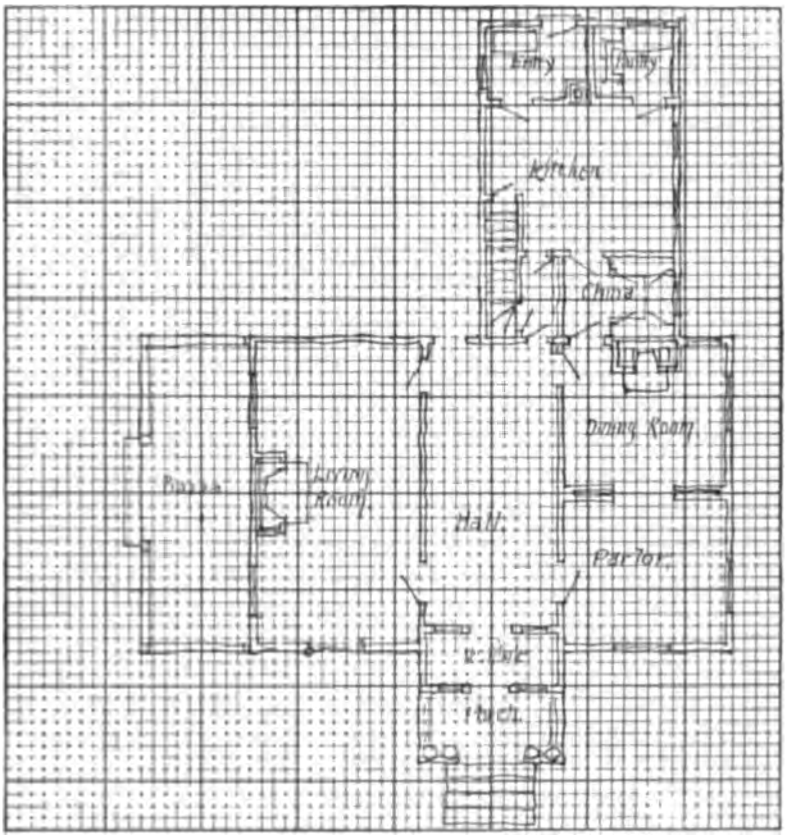


Fig. 22 Cross-Section Paper.

Materials for Sketching. At first it is a good idea to use cross-section paper, paper ruled in squares of ¼ in. or less, which makes it easier to draw at right angles; but from the moment that the draftsman is able to get along without these lines he should employ only blank paper. A small sketch book should be carried in the pocket. For small pencil sketches a smooth paper (metallic paper) gives crisp effects, but much rubbing cannot be done. A gray paper gives good effects with pencil or color used as a medium, chalk or Chinese white giving the high lights.

The sketches can be made in pencil, charcoal, ink, crayon, or in colors; the medium of expression is of little importance, as, after having learned to see an object rightly, the drawing can be made, as Ruskin says, "with a stick of wood charred at the end." A sketch should be light and clear. Shadows may be cast, but merely to express the projections, and should be only lightly shaded in.

Subjects to Sketch. In almost every city there are small classes in freehand and charcoal drawing which the architectural student should, if possible, attend; and in connection with every art museum there are generally day and evening classes. But great progress may be made by individual work in drawing interesting objects. Do not commence with making a sketch of a whole building. Sketch individual features, like a doorway, some ornament, etc. Sketches of buildings or motives of buildings should be made in direct projection as well as in perspective. The sketches in perspective will help to explain the geometrical sketches and to teach the student to think in three dimensions.

A great deal can be learned by copying photographs of good work, but the greatest benefit is derived by drawing from nature. By the latter the student learns almost unconsciously the laws of perspective, form, and proportion, and above all learns to think "in the solid." It leads to the appreciation of the fact that architectural drawing is the expression of solids, and in order that these solids shall be successfully shown, the one that draws them has to see them in his mind's eye as they actually are going to appear when built.

He should be very careful in the selection of his models to draw from, and choose only such that are beautiful. Too often the student is told to draw no matter what, under the pretext that it is always an exercise. Without doubt it is difficult to draw any model at first exactly, but what does it amount to if he occupies his time with copying those things which do not stimulate and develop his sense of beauty. There is no better practice than to draw a flower, a leaf; and if he has access to museums, etc., he should draw from the antique models, sculpture, and ornamental subjects. By drawing the latter he can learn besides how in olden times natural objects were conventionalized for use in decoration.

Memory sketches are excellent practice. Go to see a model, study it as carefully as possible; then go home and make a sketch of it. The student may be sure that his memory will betray him, and he should go back to the subject and study it again and again—twice or three times if necessary—after which he will finally arrive at a reasonably accurate sketch.

MEASURED WORK.

There are two occasions for making measurements of old buildings; one, when it is proposed to make alterations; the other, for the sake of study, making drawings of portions either for immediate study or future reference.

Materials. It is a good plan if possible to take a small drawing board, T-square, and triangles to the building. Cross-section paper ruled one-eighth inch between light lines and one inch between heavy lines is very convenient. See illustration, Fig. 22, showing use of cross-section paper. Drawings may be laid out directly to scale on this paper, at one-eighth, one-quarter, or one-sixteenth inch to the foot, or details drawn at three-quarters inch to the foot, or full size.

Measuring Tapes. The dimensions should be taken with a tape, and for architectural work a "metallic" tape or cloth reinforced with fine wires and having clear figures, is very satisfactory, though it will be advisable to use a steel tape for very accurate work.

Datum Lines. As a general rule, it is best in frame buildings to take the horizontal measurements on the sill line, making a small section to show the relation of the sill to the walls. In brick and stone buildings they should be taken on the outside wall face or ashlar line. For heights, the finished floor levels should be taken as starting points, the main first floor of the building being the general datum. If there are many projections in plan it will be well to draw a straight base line and measure it from this line. If old buildings are out of level it will be necessary to use a straight edge or draw a level line on the wall and measure up and down from this level.

Hand Level. The hand level will be found very convenient for obtaining approximately the grades about the building. This is a small instrument used by railroad engineers in working out the elevations on each side of the track. The level can be also obtained by looking toward the horizon, pulling down the hat brim until the point coincides with it, turning on the heel carry the horizon level to the direction desired. This will give a point at the level with the eye.

Elevation Measurements. Total distances should be taken, and interior heights from floor to floor (with thickness of floors) should be run from basement floor to top of roof, and if possible a line should be dropped down the outside of the building to check this. It is well to mark size of glass, and give outside dimensions of sashes, taking dimensions to centers of windows or edges of stone or brick openings. Measurements are given by some architects from frame to glass openings. Sketches or details should be made of typical windows, and variations from the type. Roof pitches may be obtained by a level and measuring the rise per foot, or outside dimensions and total rise may be taken. A convenient instrument for doing this work is a twelve-inch single-jointed rule and level, shown in Fig. 23.

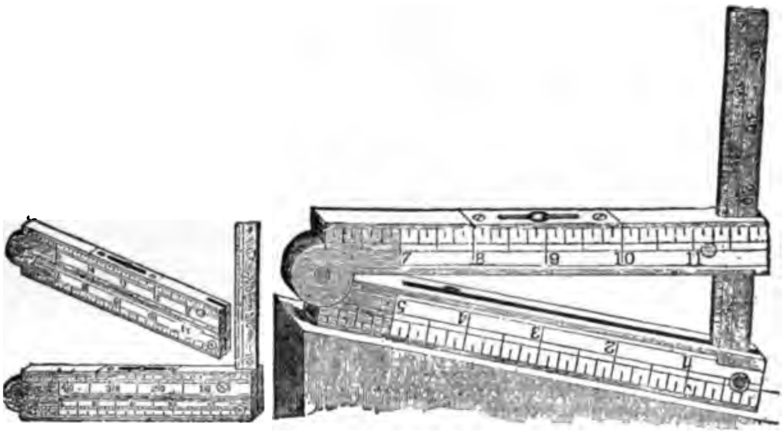


Fig. 23. Twelve-inch Single Jointed Rule and Level.

Arches. In measuring arches, the height A, Fig. 24, from the ground to the spring of the arch should be given, the total height B, and the width C. The curve is obtained by giving the length of the radii or by laying a straight edge, D F, against the curve and measuring the distance D E, which will locate one point in the curve. Other points may be taken by offsets from the straight edge.

Projections. Projections are obtained by measuring in from a plumb line. The diameter of columns may be ascertained by means of two parallel straight edges or by dividing the circumference by 3.1416.

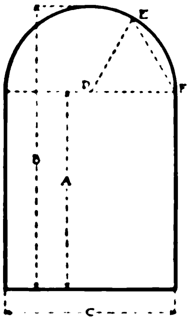
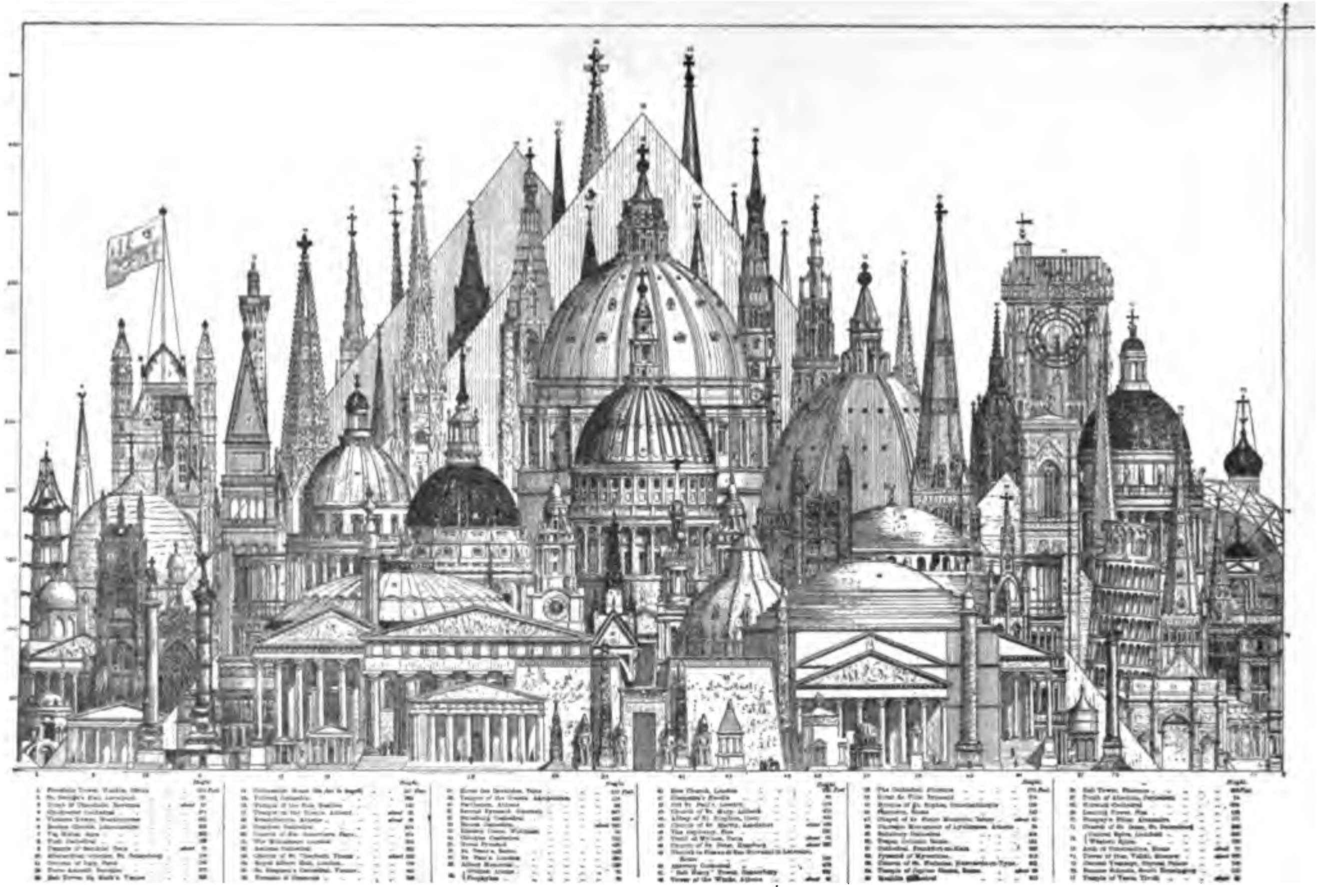


Fig. 24. Measurement of Arches.

Inaccessible Portions. In places where it is impossible to reach the point it is desired to measure there are several ways of obtaining the dimensions with considerable accuracy. A photograph should always be taken of the building measured, and a proportional scale can be made from the known dimensions, which can be used on the photograph for determining unknown dimensions.

Approximations. In brick, stone, clapboarded or shingled buildings the different courses may be counted and the totals figured from those that can be measured. Where rapid memorandum sketches are made distances may be easily obtained by pacing, some men taking nearly a three-foot pace, others walking easily five feet in two steps. In this case every other step is counted as five feet. The total heights may be obtained by measuring up as high as can be reached, then standing at a distance, holding a pencil at this known height, measuring the distance by the eye to the top of the building. Or, a man's height can be taken to gauge the approximate height. The foot rule may be held up at such a distance from the eye that every quarter inch corresponds to a foot on the building, and the dimensions can be read off in this way.

Rubbings. Rubbings may be taken of tablets, lettering and flat ornaments by laying paper on the ornament and rubbing over it with a shoemakers' heel ball. The pattern cut in will be left white and the rest of the surface will be blackened by the heel ball.



COMPARATIVE HEIGHTS OF SOME OF THE PRINCIPAL BUILDINGS OF THE WORLD

From the Wall Diagram at the South Kensington Museum.

Note:—Authorities Differ with Regard to the Height of Many of These Buildings.

ARCHITECTURAL DRAWING

PART II

PRACTICAL PROBLEMS IN DESIGN

NOTES ON THEORY OF DESIGN

Composition. It is impossible to formulate laws of composition which, even if faithfully observed, will absolutely insure satisfactory results. That is to say, any work of art—such as a picture, a statue, or a building—may comply with all the general laws of composition and still not be really artistic.

A great deal depends on the feeling of the designer. A carpenter may make a cornice for the exterior of a house, or a mantel-piece for the interior, without having been taught any of the formal laws of composition; and nevertheless, by careful study and through the desire to build something pleasing, may produce something much more artistic than the most carefully wrought effort of a designer who knows all these so-called laws but lacks all artistic feeling.

Workmen in the various trades can assist the architect materially in producing an artistic result. One of the most desirable characteristics in a workman is that he shall execute the wishes of the owner as expressed in the architect's drawings, and carry them out as artistically as possible in every detail. There is a certain character in every piece of work which every workman should try to understand and carry out in a simple, frank, decisive, and straightforward way. Every workman feels the value of truthfulness in work, and objects to sham in doing good work.

Turner, the great English painter, was a man who did everything that he had to do, no matter how trivial, well. John Ruskin says of him, in his lectures on architecture and painting:

> "He took a poor price that he might live; but he made noble drawings that he might learn. He never let a drawing leave his hands without having made a step in advance and having done better in it than he had ever done before."

Composition is the art of bringing together various interesting details, so that the whole result will be harmonious and pleasing.

The important features should be on axes, or grouped symmetrically on either side of an imaginary center line. For instance, in a room, if the fire place is to be one of the features, it should be centered on one of the axes of the room. The remaining features should be arranged with relation to the axes or center lines of the room so that as a mass they will balance each other.

In a good composition some single feature should dominate—for example, in a building, the main gable, or a tower, or a long, simple roof line; or in a room, the fireplace or a painting; etc. In decorating a house, the general effect should be pleasing, and should not be too much broken up by spotted details. There must not be too many equally interesting points; otherwise the result is either monotony or competition; one point must dominate. There must not, for example, be other gables competing with the main gable by being too near the size of the main gable. For the same reason it is better to group windows and other features in odd numbers and accent the central one.

It is well to think of the location of the different interesting points. In a cottage—to take an example—the gable that is seen from the best point of view should be near the center of the perspective; or, again, a tower should not be isolated or appear so much at one side from the best point of view that it will look as if disconnected from the house.

The smaller parts of the composition should have a proper relation to the main motive. The dormers, for instance, in a cottage, should be in the same style as the main gable, or in harmony with the style.

Nevertheless, all these different parts must be used so that there will be some contrast, in order to give life and interest to the composition. No detail from a different style, however, should be brought in without the designer being sure that the harmony of the composition is not thereby disturbed. To learn how to compose, it is not sufficient to study books and receive instruction in the school or in the drafting room; the student must supplement this with the study of nature and of objects and buildings themselves.

Scale. The word "scale" has been used to designate a measure of distance—for example, a scale of one-quarter of an inch to a foot.

"Scale" is used also in another sense—that is, to designate the appearance of a building or any artistic composition, which, without

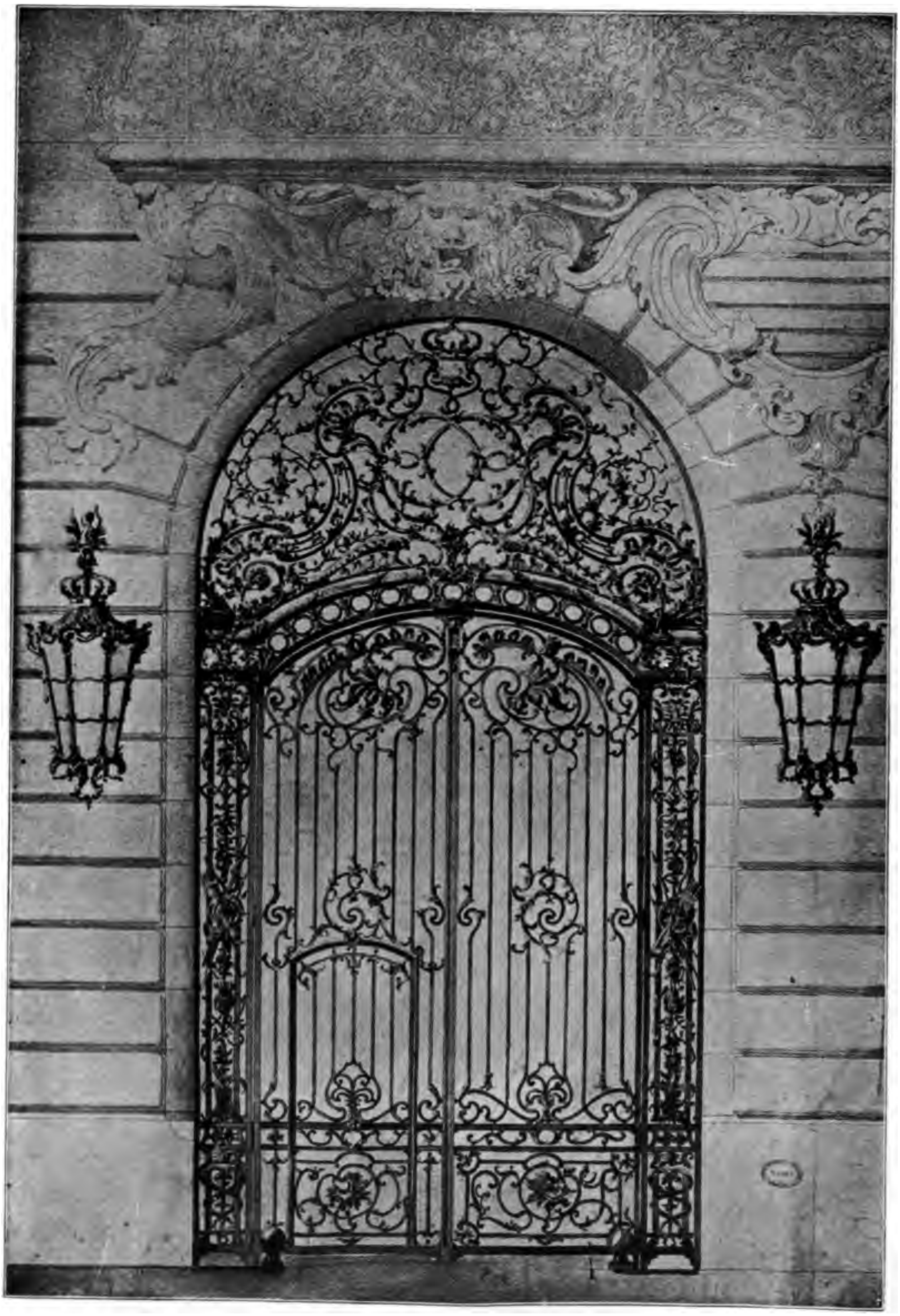
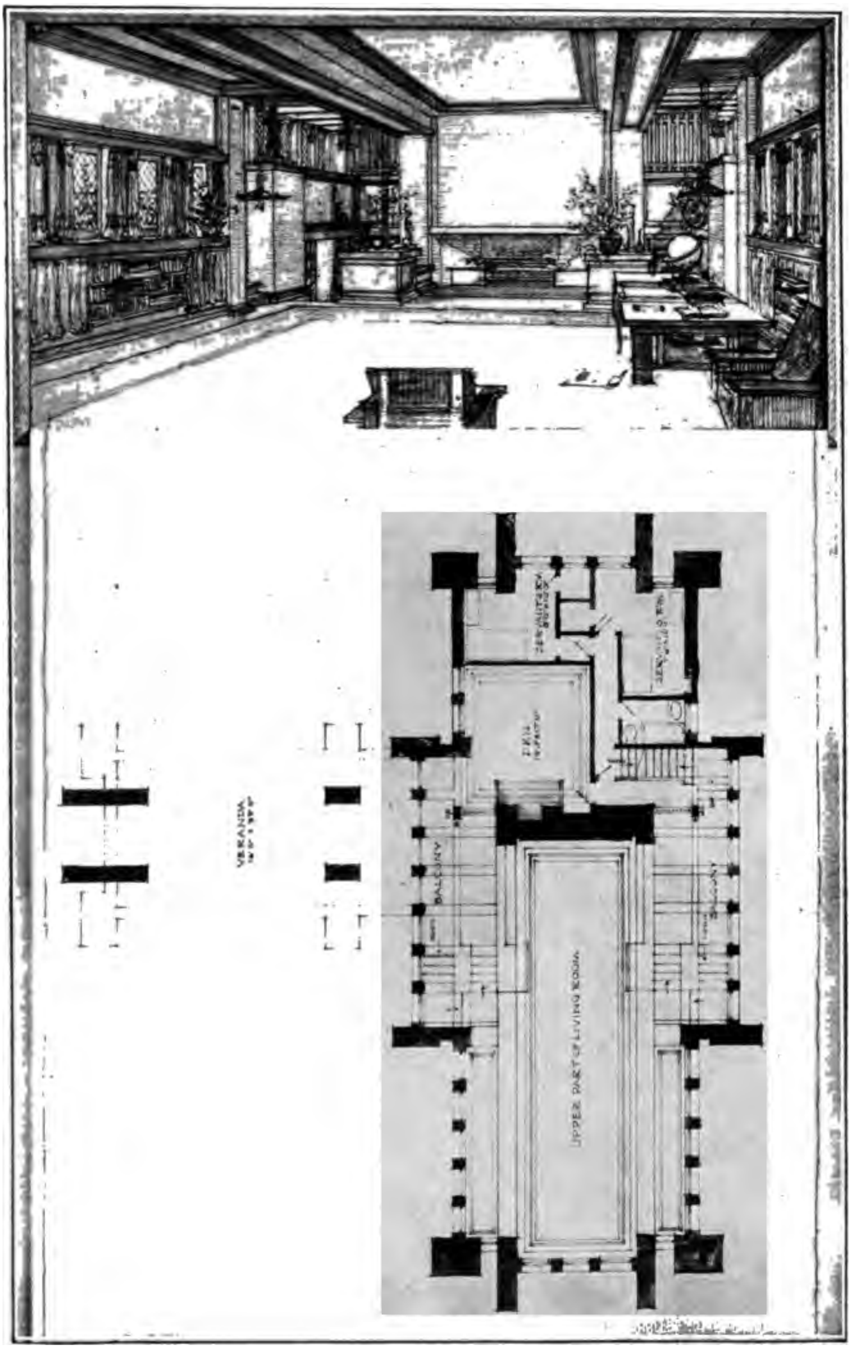


ILLUSTRATION OF THE DIFFERENCE IN RENDERING STONE AND METAL



DESIGN FOR LIVING ROOM IN RESIDENCE OF MR. H. J. ULLMAN, OAK PARK, ILL.
Frank Lloyd Wright, Architect, Oak Park, Ill.

considering the actual dimensions, gives us an idea of the size. For example, in the two sketches A and B (Fig. 25) the two vases have the same proportion; but one is a huge decorative vase standing at the side of a fireplace, while the other is a small vase standing on a table.

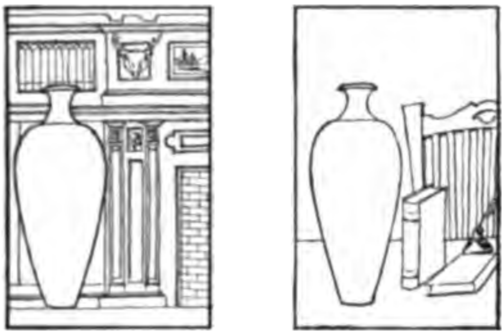


Fig. 25.

It requires the books and other details of well known dimensions to suggest the small scale of the one, and the mantel-piece to suggest the scale of the other. The same principle is seen in doors and windows, in the effect of steps in front of a building, in balustrades, and in all details with which we are familiar in our daily life.

A drawing is "large in scale" when it appears to be drawn at a larger scale than has been really used; for example, a drawing of a building might look as if it were laid out at quarter-inch scale when it was really laid out at one-eighth-inch scale. If such a building were erected, it would be much larger than the drawing would indicate. On the other hand, if it is "small in scale," the details are too small and the building will appear as if it were built for dwarfs.

The materials used in construction affect the scale of a building—such as sizes of brick, stone, clapboards, etc. Arches span larger spaces than lintels; iron construction needs fewer supports than stone construction. The detail should be somewhat larger in scale in the upper part of a building, where it is seen from the ground, from what it is in the lower portion near the observer. Interior detail should be finer and smaller than exterior detail.

Statuary, when called "life-size," is actually made about one-quarter of the height larger than life size. The reason for this is that objects in the open air, or in large spaces, look smaller than they actually are. The size also depends largely on the height from the ground.

If a building does not appear to be in good scale—that is, if the drawing does not suggest the actual size of the building (which may be tested by sketching in a figure of a man, and measuring to see if the house is in scale or not), the detail should be studied to see that it is not too large or too small; other details may be added, such as steps or balustrades; or, if the design is an interior, the walls may be decorated with natural objects in the right scale. Anything that will suggest the height of the human figure may be used, or stone joints and other suggestions of material may be made more evident.

Ornament. Architectural ornament is the decorative treatment of architectural motives on a building. The ornament should be carefully studied on the small-scale designs, and worked up from these to the working drawings.

All ornamentation or decoration should be drawn out on each design, and particularly on the small-scale drawings, even if it is to be carried out by other designers, modelers, or decorators; for it should be remembered that the one man who is to bring together into a single composition all the elements of a design, is the Architect. The decoration, whether sculptured or painted, is executed either from scale details or full-size drawings, by the decorator or sculptor. If any change is made from the main lines of the design, this change should be studied on the small-scale drawings; otherwise it may be found that the detail is entirely out of scale with the general architectural lines.

It should be clearly understood that loading a building, a mantel, a cornice,or any motive with ornament does not make it a work of art. Everything depends on where and how the ornament is applied. Besides, generally, any motive is more artistic if it is perfectly simple.

Criticism. All through the work of design, it is of greatest advantage if criticism can be obtained from other architects and draftsmen; and even the criticism of outsiders, conscientiously made, will frequently suggest valuable improvements in design. Whenever an intelligent criticism is received which suggests a change, it should be a matter of principle with every designer to make a sketch embodying this change, in order to see whether or not the criticism is good.

DESIGN OF THE DWELLING

The plan of the modern residence began to be worked out in the 18th century. There is a treatise on architecture published at that time by Blondel, who says that a complete reformation had been made in the architecture of large and small dwellings from the point of view principally of the arrangement of rooms; great efforts had been made to substitute for the long, rambling succession of single rooms, an arrangement of rooms double in depth, with separate communications so indispensable for conveniences in a building.

It became clear that in a dwelling the ease of circulation was very important, and that the approaches to and exits from the various parts had to be well worked out, for the living rooms as well as for the service rooms. The aim of architects in the 18th century was for *independence* in the house, and it is to this that we owe their very remarkable plans.

The treatise on architecture by Blondel contains many interesting plans, well worthy of careful study. On the subject of Room, in particular, Blondel gives some interesting data:

> "It seems", he says, "that within about fifty years French architects have, in this respect, invented a new art. Before this, our edifices in France, in imitation of those of Italy, had an exterior decoration which made a very beautiful architecture; but the interiors were hardly livable. The architects seem to have tried to keep out the light; one could hardly find a place for a bed and for the principal articles of furniture. The fireplace occupied the largest part of the rooms, and the smallness of the doors gave an inadequate idea of the places to which they gave entrance . . . . The arrangement should be the first object of the architect; decoration depends absolutely on a well-studied plan. It is the arrangement which establishes the length or width and the height of a building."

Number of Rooms. The great objection to many small houses is that the people want the same number of rooms for a small amount of money that others have where more money has been spent. A desire to have six rooms and a bath often results in making all the rooms tiny and uncomfortable—more like boxes than living, habitable spaces. These houses are not necessarily cozy just because they are small; a cozy corner in a big room has much more of the cozy feeling than is found in the small rooms of an apartment. There should be one good-sized room in every house or apartment, even though one room has to be sacrificed.

Hallway. The hallway should be neither a cramped, narrow space, nor arranged in such a way that it will be a draughty part of the house. It should be borne in mind that if open from first floor to roof, the heat will pass up the hallway; for that reason it should be sufficiently closed off from the other rooms. It may be arranged as a comfortable gathering place for the family. Indeed, with the staircase kept properly to one side, and with a large fireplace the hallway may form the central room of the whole house.

Stairways. Some men say that they build a house around a bathroom, because they consider that the most important room in the house. Next in importance is the staircase. The front staircase should be easy and large. A 7 to 7½-inch rise, with 10 to 10½-inch width of tread, is customary, though a 6½-inch rise with an 11-inch tread is easier and looks much better. Staircases, in the better class of house, may be as easy as 6-inch rise by 14-inch tread, or even 5½-inch rise with 15-inch tread. In back staircases a 7-inch rise with 9-inch tread is not too steep; and they are frequently found as steep as 8-inch tread. If space allows, the rear staircase should be sufficiently wide to take up trunks and furniture—say 3½ to 4 feet, with wide doors (3 feet 3 inches) opening into it. In this case the stairs should be strongly supported. Staircases may be made fire-resisting by stopping the space between the stringers with brick and by covering the underside or soffit with metal lath.

Proportion of Stair Riser to Tread. A good formula to use in laying out a stairway is as follows: Let R = the rise and T = the tread, then

$$2\,R + T = 25.$$

i. e., twice the height of the riser plus the width of the tread should equal 25 inches.

Living Rooms. The living room, library, parlor, reception room, should all be "livable." The shut-up "best room" is a thing of the past.

Sitting Room. This should have a southerly exposure, so that it will be sunny and cheerful all the time.

The best arrangement for a sitting room is with the fireplace at one end, the windows on the long side, and the entrance at the further corner. The next best arrangement is with the fireplace on the same side of the room as the entrance, and both on the long side of the room. The most unsatisfactory arrangement is to have the door on the wall opposite the fireplace or close by the fireplace, where there is a constant draft.

The room should express comfort and restfulness. There should be no feeling of over-decoration, and nothing in the room should be so striking as to be the first and only thing to be seen. The great objection to so-called "decoration", is that each decorator or designer thinks only of his own work, consequently making it prominent; and it is extremely difficult to make the decorative elements harmonize.

Dining Room. The dining room should be, as a rule, on the side of the house toward the morning sun. It should be cool in summer and warm in winter, as it is the one room that is necessarily occupied at least three times a day. A westerly outlook is generally disagreeable on account of the low-lying sun for the evening meal.

Butler's Pantry. The butler's pantry should have an outside window, and doors leading into the dining room and kitchen. Sometimes a slide is put in, opening into a small china closet in the dining room. The butler's pantry should be quite large. The story is told, of an architect who dined with his client several times while he was making the sketches; and each time, on his return to his office, he enlarged the butler's pantry, and when the building was erected it was still one of the cramped rooms in the house.

Kitchen. The kitchen should not be placed in too close proximity to the living rooms, and should be on the northwest corner of the house. As a rule, it should be separated from the living parts of the house by at least two doors. This is done, partly on account of the odors from the cooking, and also because of the heat. A basement kitchen is objectionable on this account. The kitchen should be thoroughly ventilated, the windows being set high—as near the ceiling as possible—to let out the hot air, the sill being located above the backs of the tables and sinks. A hood over the range connecting with a ventilating flue, is very useful for ventilating. This ventilating flue will be either a space around the flue from the kitchen range, which will be constantly warm; or it may be a separate, square flue next the smoke flue in the chimney. It is advisable sometimes to put deafening felt over the kitchen, so as to prevent the passage of sound and heat if there are sleeping rooms above.

Refrigerator. The refrigerator should be located so that it will be easily accessible from the outside, for putting in ice; and it should be near the kitchen without being too near the range. The refrigerator drip should never connect directly with the sewer but should have a separate pipe leading to a dry well outside the building. The simplest and cleanest way to trap this is as follows: Build a galvanized-iron pan large enough to rest on the floor under the drip-pipe of the refrigerator; and carry lead pipe from this down into the cellar, ending in an ordinary milk jar which stands in another galvanized-iron drip-pan connecting with the dry well.

Storeroom. The storeroom may be made rat-proof by plastering on metal instead of wooden lath, and by plastering the ceiling underneath with the same lathing, taking the precaution to cover all openings.

Bathroom. The bathroom may have tile floor and walls, or, for ordinary work, a Georgia pine floor, with North Carolina pine sheathing four feet above the floor. A sanitary base—that is, one rounded to avoid a corner between the wall and the floor, such as is used in hospitals and in many schoolhouses, may be used. Waterproof paper should be put in between the upper and the under floor in the bathroom, being connected by lead flashing with the outside of the building. This will prevent damage in the case of an unexpected overflow.

Lavatory. A lavatory on the first floor is very convenient. This may open from the hall or be connected with a coat closet. It should have a window.

Closets. The closet doors should open in such a way that the light from the window shines into the closet.

On the sleeping-room floor, a housemaid's closet may be provided—if possible with an outside window. This closet should contain a galvanized -iron or enameled-iron sink, provided with a flushing tank as well as with hot and cold water faucets.

The linen closet should preferably have no drawers, as they furnish hiding places for mice. Shelves will answer every purpose.

Bicycle and dark rooms, play room, sewing room, billiard room, music room, den, conservatory, etc., should also be considered.

Cellar. The cellar should be well drained, if possible, with a drain-pipe separate from the soil-pipe. There should be a blind drain under the wall, and the wall should be damp-proofed in damp locations, by the use of layers of slate stone extending through the wall at the surface of the ground, or layers of well-tarred paper at this point.

Waterproof cellars are made by putting down several layers of tarred paper well mopped with hot tar or asphalt, on which the concrete cellar floor is laid. As a rule, however, it is best to have the cellar connected either with the soil-pipe or with the blind drain, and to have all the concreting put in so that it will slope to one point, where will be placed a trap with grating.

VARIOUS STAGES IN BUILDING A HOUSE

The point where the majority of people, who know nothing about architecture, come in contact with the architect, is when they make up their minds to build houses of their own.

To develop this point more clearly, let us consider the situation that arises when a business man wishes to build.

The problem, as it comes to most men, is a question of number of rooms needed, amount of money available, and proposed location of house.

Let us say that Mr. Smith, after lookng at various lots and making as many inquiries as possible through friends and acquaintances, and having also gone to some real estate agent who deals largely in land in such locations as he considers desirable, has obtained an option on, or possibly has purchased, a lot, the price being, say, $800. He has available $2,000, besides the money he has set aside for furnishing the house and paying the architect's fee. He is willing to give a mortgage on the house for, say, $3,000. Taking $4,600 as the value of his proposed house would leave him a margin of $400. Accordingly, he goes to an architect who, he he thinks, will plan his house satisfactorily, and tells him the circumstances, the requirements, and the amount of money available. A visit is made to the lot, to get the points of view, etc., and preliminary sketches are made.

Sketches. From the architect's point of view, the sketch period is vital in respect to the success or failure of the house. It is at this time that he becomes acquainted with the owner's ideas and does his best to interpret them properly so that there will be no criticism or feeling of disappointment on the part of the owner—in other words, so that the house will harmonize completely with its owner's habits and tastes.

Every man has certain hobbies and independent wishes in regard to his house; these the architect should study and give the proper expression.

In regard to the practical use of the house, every member of the family, should be thought of and consulted. The architect should obtain a careful outline of the requirements from the owner, going over the number of rooms, size of rooms, comparing them with rooms already known to the owner, heights of stories, location and exposure of rooms, for the view, etc.

After sufficient data have been procured to make a complete schedule, several different plans of the proposed house may be sketched out at a small scale. Co-ordinate or section paper is very useful in sketching out different schemes. As a general rule, it is better for the architect to work out with great care some one plan which he considers the most satisfactory. In dealing with some clients, it is sometimes better to show this plan only; in the case of other clients, it is better to show them all the studies and consult with them about details that would be merely wearisome to other men. The sketches are generally laid out to the scale of one-eighth inch to the foot, though small "thumb-nail" sketches are frequently made at no scale, or sometimes several different schemes at a scale of one-sixteenth inch to the foot. Memoranda should be kept of all conversations with the client, for use in completing plans and in writing specifications.

Working Drawings. After the sketches are approved, the working drawings can be started. They are sometimes called "contract drawings," meaning the scale drawings accompanying the specifications and contract, though contract drawings really include the details, which are not generally made at the time the contract is signed. The character of these drawings has changed very much, even in the last few years, an astonishing amount of detail being put into the working drawings, while the architectural drawings of the English and Italian Renaissance show that the old masters must have studied much of their detail while the building was being erected. The main purpose of the working drawings is to give complete information of the building to be erected, as far as size and form can be expressed in projection, quality and general description being left to the specification. It is of considerable importance to put on a single drawing as much as can be clearly expressed, since workmen generally are not inclined or able to gather information from several different drawings.

The working drawings are laid out at quarter-inch scale,* *i.e.* one-quarter inch equals one foot, with details at a scale of three-quarter inch to the foot, accompanied with full-size details. This is the customary scale in America. In England and also in some American offices, the rule is to make the working drawings at a scale of one-eighth inch to the foot, with details at a scale of one-half inch to the foot.

Plans of every floor, including basement and roof, all the elevations, and such sections as may be necessary to explain the construction, are required. In the sections, the vertical dimensions should be figured from finished floors.

Besides these drawings, a block or ground plan is frequently given, generally at $\frac{1}{16}$ or $\frac{1}{32}$ inch to the foot, to show adjacent walls, gardens, etc., and layout of grounds, location of drains, dry wells, cesspool, and water supply.

Separate plans may be given in procuring estimates for heating, ventilating, plumbing, and gas and electric lighting. These should be made subject to changes that may be proposed by the successful bidder, and, with these changes, should be presented by him to the architect for approval before finally going ahead with the work. This method is followed, because a guarantee is expected from the contractor for the successful operation of his work; and each contractor in the trades mentioned is likely to have good methods of his own, which he should be allowed to use. Sometimes all of these drawings may be incorporated in the general drawings.

Full-Size Details. Mouldings, and special parts of exterior and interior finish, such as base-courses, water-table, belts, cornices, capitals, special arrangement of brickwork, panels, carving, window-casings, mantels, stair-newels, balusters, etc., are drawn full size; carefully drawn sections are made full size. "Key drawings" at small scale, isometrics, and freehand perspectives are invaluable aids if drawn on the full size drawings. For cast iron and terra-cotta, allowance is sometimes made for shrinkage. This should preferably be left to the pattern-maker.

*NOTE:—There is a great difference between "quarter-inch scale" (*i.e.*, ¼ inch = 1 foot) and "quarter scale," or one-quarter of full size (*i.e.*, 3 inches = 1 foot).

Besides the contract drawings and subsequent detail drawings, other drawings are frequently called for, for which allowances have been made in the contract, as for furniture, special finish, etc.

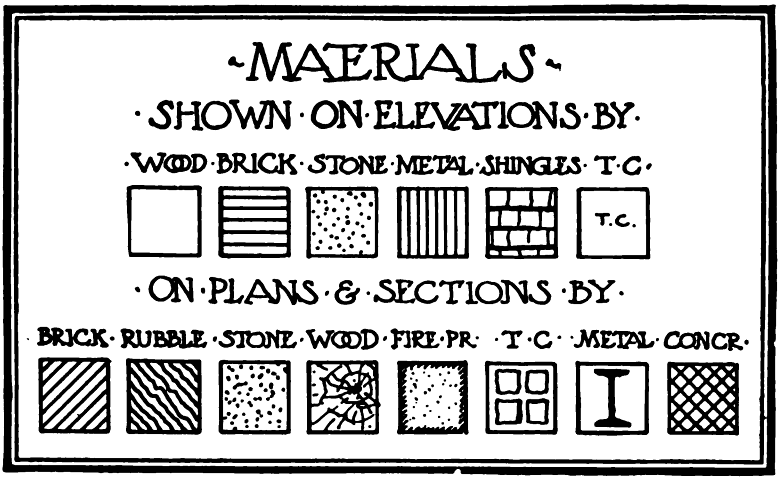

MATERIALS
SHOWN ON ELEVATIONS BY
WOOD BRICK STONE METAL SHINGLES T.C.
T.C.
ON PLANS & SECTIONS BY
BRICK RUBBLE STONE WOOD FIRE-PR. T.C. METAL CONCR.

Fig. 26.

Representation of Materials. This may be either by blacking in, hatching, etc., or by use of colors. The former method (Fig. 26) is convenient for tracings to be blue-printed, as it saves coloring the prints.

On elevations, materials are shown as follows:

Wood	white.
Brick	horizontal lines.
Stone	dotted.
Metal	vertical lines.
Shingles	sketched to scale.
Terra-cotta, etc	abbreviations marked "T.C.", etc

On plans and sections:

Brick	diagonal hatching, ruled lines.
Rubble	diagonal hatching, wavy lines.
Stone	dotted.
Wood	grain indicated, or black if small-scale.
Fireproofing	hatched margin, dotted surface.
Terra-cotta	divisions to suggest material.
Metal	steel sections suggested.
Concrete	cross-hatched.
Old work	white.

If colors are preferred, the following may be used:

Brass and copper	yellow.
Brick	light red.
Concrete	Payne's grey, mottled.
Glass	new blue.
Glass in elevations	a graded wash of India ink, indigo, new blue with a little carmine.
Old work	grey or black.
Plaster	Payne's grey.
Sections	construction not determined, pink with red border line.
Shadow in elevation	India ink with indigo or gallstone.
Slate	indigo.
Steel and iron	Prussian blue.
Stone	raw umber or new blue, or Payne's grey.
Terra-cotta	burnt umber.
Tiling	light red with yellow.
Wood	yellow ochre.

Coloring may be carried further, following this scheme, always placing guide-squares in one corner of the drawing with the names of the materials represented.

Tracing and Blue-Printing. Drawings of which several copies are needed, may be traced on transparent paper or linen, or laid out directly on these materials. Thin bond paper is often used. Prints may be taken from these, either blue or brown prints, giving white lines on a blue or brown ground, or by first taking negatives, dark lines on a white ground.

Notes should be kept for the specifications while drawings are being made.

Letting the Contract. When the working drawings and specifications are finished, owner and architect decide on three or four builders, any one of whom would be satisfactory, who are asked to submit estimates. The builders are allowed time enough to go over the plans and specifications carefully so that they may know the actual value of the work; and bids are sent in to the architect's office to be opened on a certain day, when the owner meets the successful bidder and a contract is signed for building the house.

In France there is generally a separate contractor for each kind of work; in England a general contractor makes up his bid from quantities given him by a quantity-surveyor; in America usually the sub-bids are given to a general contractor who takes the responsibility for the whole work.

The work generally starts immediately on the signing of the contract, and is carried on continuously, with visits from the owner and from the architect, payments being made at regular intervals or on completion of certain parts of the work.

During the progress of building, the owner and architect select fixtures, wall papers, etc.

BUILDINGS FOR OFFICES

The plan must be laid out so as to obtain the largest possible amount of space available; it must be made with reference to the constructive requirements.

Arrange the offices so as to take advantage of surroundings and light. A good outlook makes an office more desirable.

Staircases, elevators, piers, etc., should be arranged so that the actual renting space will be an open loft, where offices and windows can be divided up easily to suit different tenants, and can be easily changed.

Make the street entrance and corridors so that the offices can be easily reached and doors and signs easily seen. The corridors should not be less than 3 feet 8 inches wide; as a general rule, they should be 4 feet to 8 feet wide, depending upon the use, the number of offices and the size of the building.

Arrange janitor's and superintendent's offices, telephone, telegraph, news booths, and elevators so that the tenants and public may be quickly accommodated.

As a rule, unless there are two frequently used entrances, the elevators should be placed so that they can all be seen by a person entering the building.

A car 5 feet 3 inches by 6 feet, with a door on the long side and the rest of the side removable, is convenient for handling ordinary office furniture. One elevator in the building should be as large as this. Other elevators may be smaller.

If a building is more than 6 stories high, it is advisable to have one or more elevators express to the 6th story. The doors at the lowest floor, where the largest number of passengers pass in and out, and where there is generally a "starter" to see that the cars are not overcrowded, may be arranged so that the whole side of the car will open, allowing all the passengers in the elevator to pass out at once.

Staircases are rarely used in an office building. A width of 3 feet 3 inches is generally sufficient; and sometimes staircases are as small as 2 feet 9 inches.

If there is a light court, it should be of such shape and location as to receive as much sun as possible.

There should be toilet rooms on every floor; generally lavatories are placed in the separate offices. Radiators are put in front of each window, transoms over every door; the lighting is done by electricity with drop-lights and receptacles for desk-lights.

Write the specifications so that the building may be economically constructed and will be a paying investment, and yet not so cheaply built that it will be unattractive or constantly needing repairs.

PRACTICAL EXAMPLE: A COLONIAL HOUSE

Conditions. A business man, having purchased a lot sufficiently large to give him space on all sides, wishes to build a colonial house containing nine rooms.

On the first floor, a hall is to be in the center, with vestibule and porch in front and doorway at the rear, so that the air may circulate freely in the summer time. The hall is to be about 15 feet wide. At the front, on the left, opening off this hall, the owner wishes to have a large room about 14 feet by 25 feet. The parlor and dining room are to be about 14 feet by 12 feet each. On the right of the hall, next to the dining room, is to be a china closet, with shelves and drawers, connecting with the kitchen. Beyond the kitchen is to be a pantry, with shelves, cupboards, and cases of drawers. The back entry is to have a place for a refrigerator. The rear door of the front hall is to open on an ample porch, where the family may sit.

The second floor is to have four bedrooms and an alcove in the main part of the house, a convenient bathroom and bedroom in the rear, and suitable linen closets. There are to be a front stairway and a compact back stairway. The attic is to be arranged for sleeping rooms.

Sketches. The drawings first to be made are sketches at a scale of one-eighth inch to the foot, drawn on Whatman's paper, with the plans inked in and the walls shown black. The elevations may be sketched in pencil, merely the front and left-side elevations being shown.

Figs. 28 to 49 show complete working plans of a house fulfilling these conditions—a three-storied frame residence, such as is frequently constructed in our suburban country towns and smaller cities. The drawings include the basement, first floor, second floor, attic, and roof plans, front elevation, and one side elevation, corresponding framing plans, and details of different parts of the house. Details are not always included in the contract drawings, but are made as the work progresses. The rear elevation and one side elevation have been omitted, as they are of the same character as those shown. These plans are usually drawn at the scale of one-quarter inch to the foot; in the illustrations, they are reduced.

Plans. On commencing the quarter-scale, the principal dimensions should be given in feet and inches, not in fractions of an inch, to the outside line of the sill. The main contour lines should be marked first, and then the wall should be shown on the first floor, six inches thick. The sill line is shown on Fig. 29, one inch inside of the outer wall line, and is merely drawn in a little way at the corner of the building. In drawing out the plans in pencil, the lines may be run straight through, taking no notice of openings. The lines that run over can easily be erased later. In commencing to lay out the plan, it is well to draw the center lines or axes first, as all the symmetrical points of the building will be laid out from these axes. Doors and windows either center on an axis, or, as a rule, are equidistant. The bay windows and chimneys are also located if possible on the axis lines. The door and window openings in the exterior walls are not located in plan until the elevations are laid out. When this is done, the sizes of window designed on the elevation can be transferred to the plan. As mentioned previously, in working over the plans, notes should be made for the specifications and marked on the plans; for example—*g. p.* (glass panel); *c. w.* (casement window); *t. l.* (top light or transom light).

Elevations. In laying out the front elevation, the center line should be sketched in sharply, in pencil; and the location of the sill line should be marked at the right and left of this center line. Then the outside finished building line should be drawn one inch outside the sill line, this being the outside of the boarding.

Useful Memoranda. In laying out plans at one-quarter of an inch to the foot, the beginner is often puzzled to know the simplest way

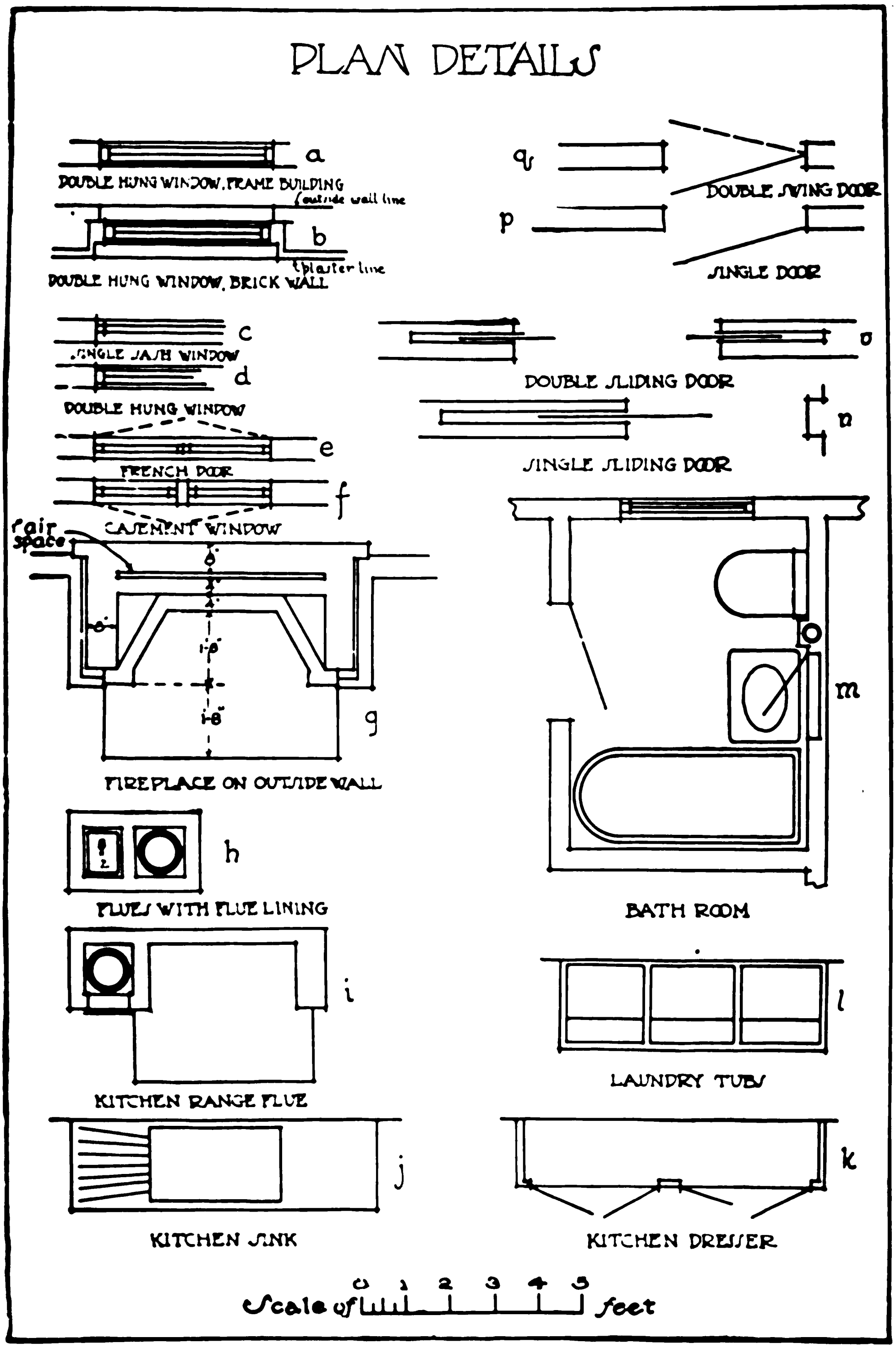
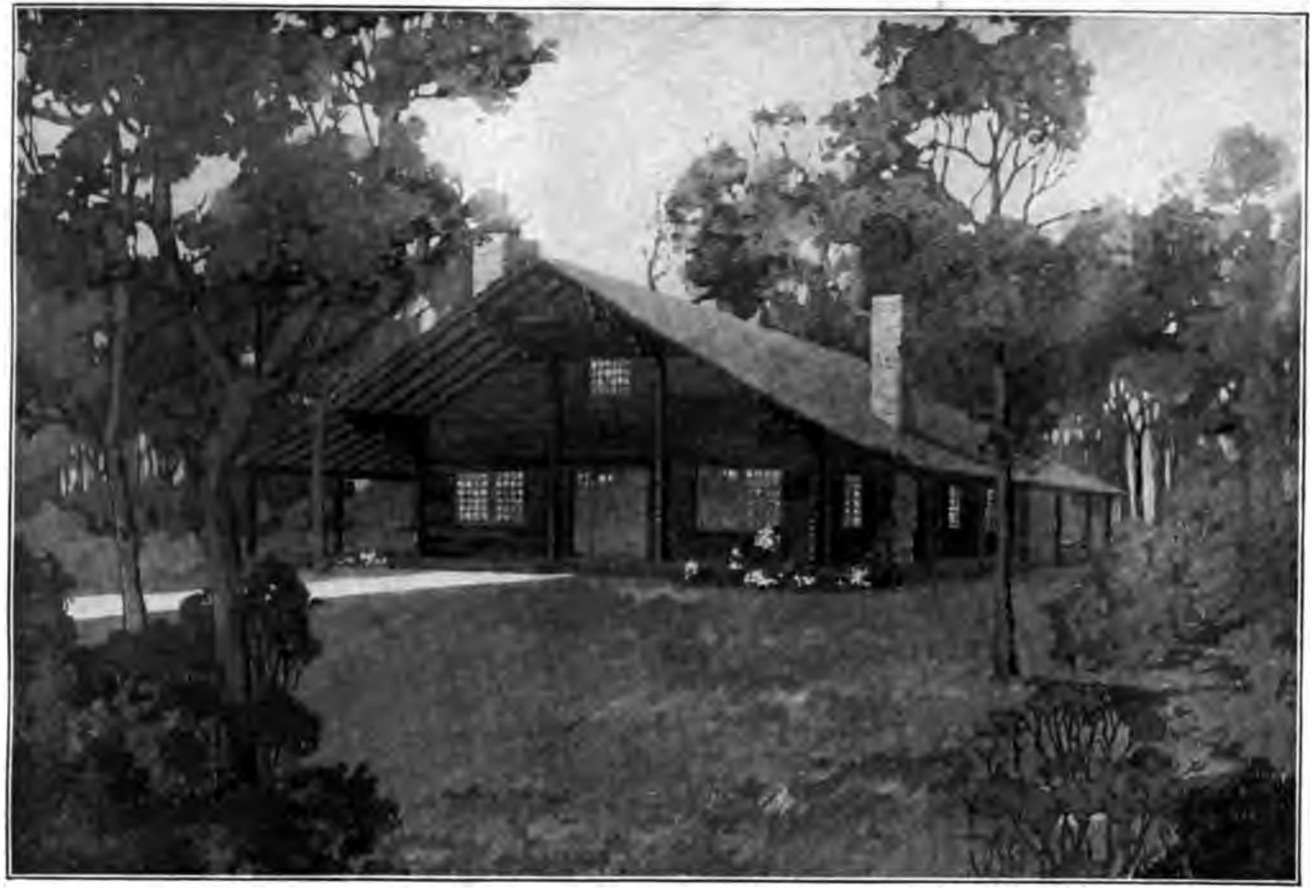
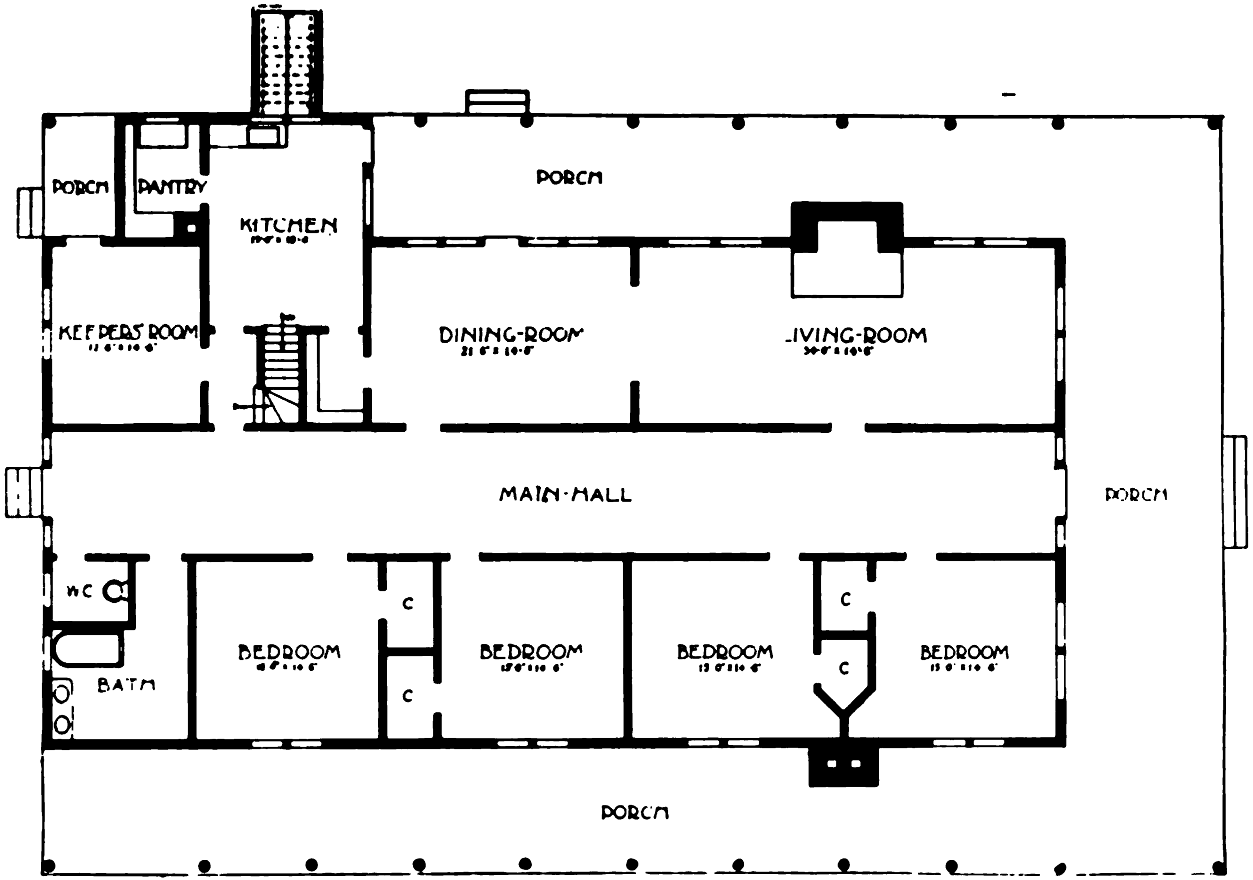

PLAN DETAILS
a
DOUBLE HUNG WINDOW, FRAME BUILDING
outside wall line
b
plaster line
DOUBLE HUNG WINDOW, BRICK WALL
c
SINGLE SASH WINDOW
d
DOUBLE HUNG WINDOW
e
FRENCH DOOR
f
CASEMENT WINDOW
air space
6"
4"
1'-8"
1'-8"
g
FIREPLACE ON OUTSIDE WALL
h
FLUES WITH FLUE LINING
i
KITCHEN RANGE FLUE
j
KITCHEN SINK
q
p
DOUBLE SWING DOOR
SINGLE DOOR
o
DOUBLE SLIDING DOOR
n
SINGLE SLIDING DOOR
m
BATH ROOM
l
LAUNDRY TUBS
k
KITCHEN DRESSER
0 1 2 3 4 5
Scale of feet

Fig. 27.



SHOOTING LODGE FOR MR. ALBERT G. MEIER, HIGHGATE, MISSOURI
Dean and Dean, Architects, Chicago
Walls of logs and roof of split shingles
For plans see opposite page



PLAN OF SHOOTING LODGE FOR MR. ALBERT G. MEIER, HIGHGATE, MO.
Dean & Dean, Architects, Chicago, Ill

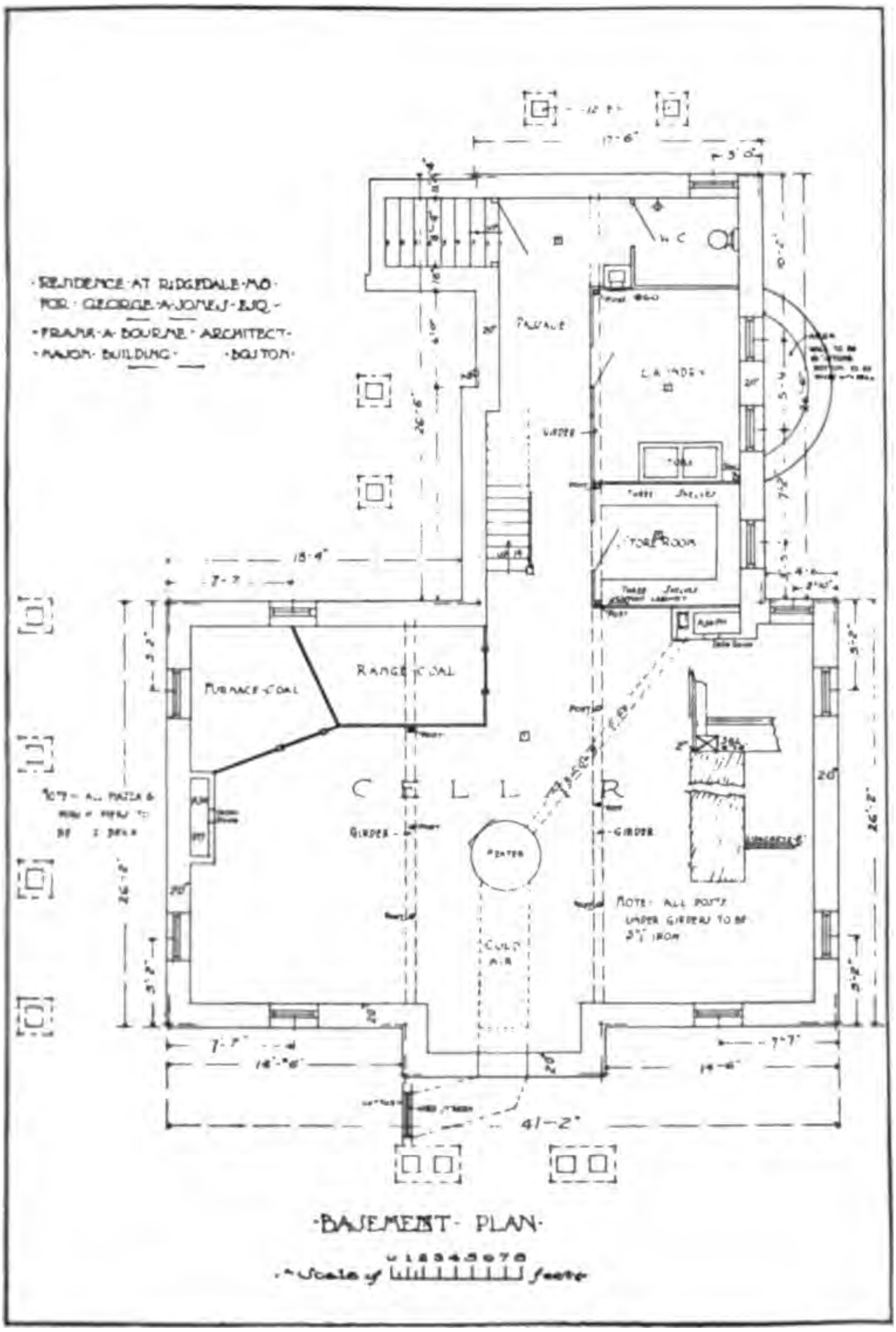

·RESIDENCE·AT·RIDGEDALE·MO·
FOR·GEORGE·A·JONES·ESQ·
·FRANK·A·BOURNE·ARCHITECT·
·MAJOR·BUILDING· ·BOSTON·
17'-6"
3'-0"
W C
PASSAGE
LAUNDRY
GIRDER
TUBS
THREE SHELVES
STORE ROOM
THREE SHELVES
POST
UP 14
15'-4"
7'-7"
RANGE COAL
FURNACE COAL
CELLAR
ASBESTOS
GIRDER
HEATER
GIRDER
COLD AIR
NOTE: ALL POSTS UNDER GIRDERS TO BE 3½" IRON
NOTE — ALL PIAZZA & PORCH PIERS TO BE OF BRICK
26'-2"
5'-2"
20"
7'-7"
14'-6"
41-2"
·BASEMENT· PLAN·
0 1 2 3 4 5 6 7 8
Scale of feet

Fig. 28.

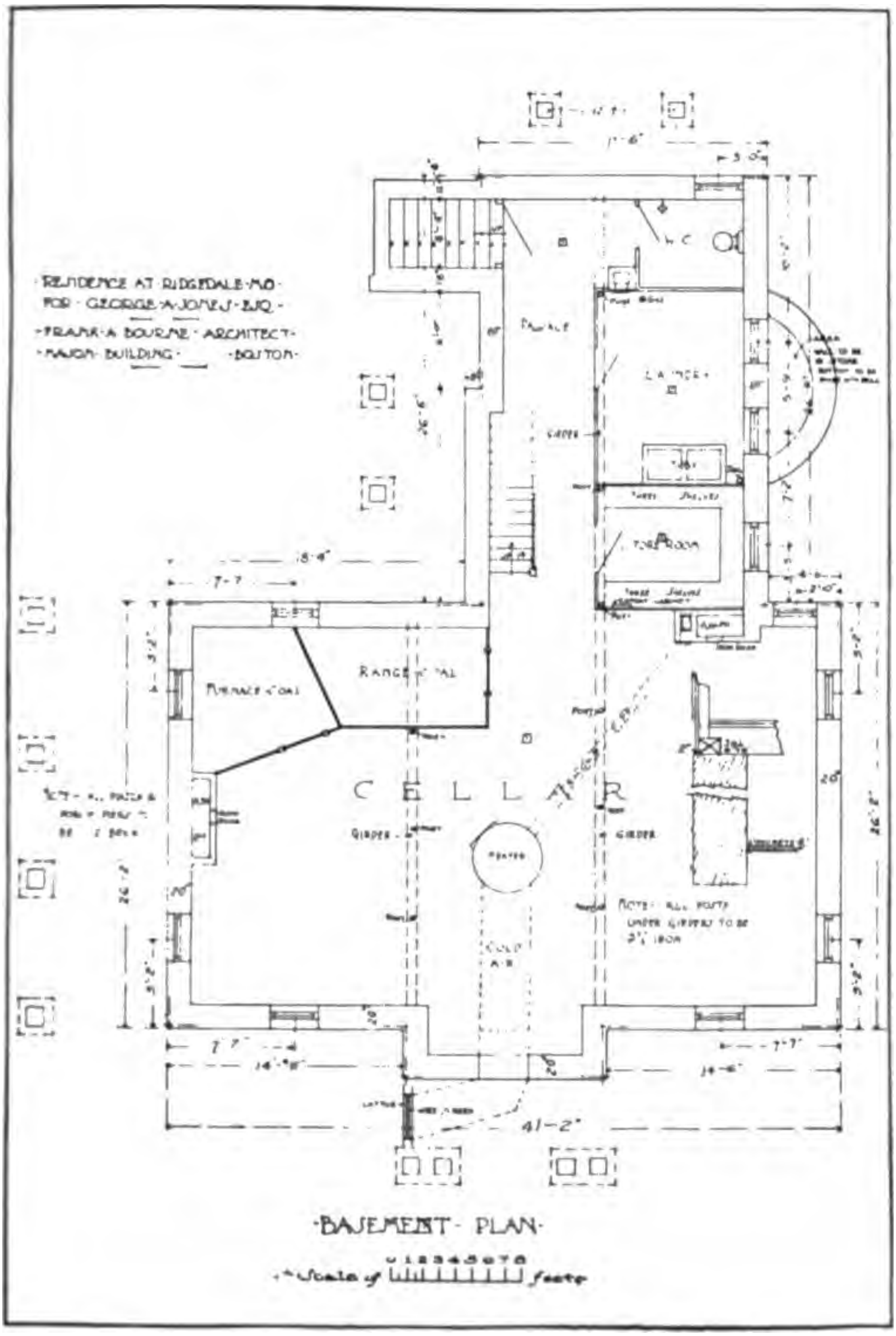

·RESIDENCE AT·RIDGEDALE·MO·
FOR · GEORGE·A·JONES·ESQ·
·FRANK·A·BOURNE·ARCHITECT·
·MASON·BUILDING· ·BOSTON·
W.C.
LAUNDRY
TUBS
STORE ROOM
GIRDER
FURNACE COAL
RANGE COAL
CELLAR
HEATER
COLD AIR
NOTE: ALL POSTS UNDER GIRDERS TO BE 3½" IRON
17'-6"
3'-0"
26'-6"
18'-4"
7'-7"
5'-2"
26'-2"
7'-7"
14'-6"
41-2"
·BASEMENT· PLAN·
0 1 2 3 4 5 6 7 8
Scale of feet

Fig. 28.

Basement Plan. Fig. 28 shows the basement plan of the residence. Dimensions are all given to the outside of the underpinning rubble wall, which in this case is 2 inches outside the sill line, as shown in the half-inch scale section. The footings of piazza piers at the front of the house are shown dotted. On the left side of the piazza is lattice-work covering the opening into the cold-air box for the furnace. The underpinning is of stone 20 inches thick; and the piazza piers are 12 inches square, built of bricks. The posts holding the girders are usually made of iron, three-quarter-inch metal, three and one-half inches in diameter. Sometimes these posts are made of iron about one-quarter inch thick, filled with concrete, the cost being about the same as that of brick piers, with the advantage of taking up less space than the latter in the cellar. The footings of the chimneys are not shown; the ash-pit under the chimney has an iron door for cleaning; and the coal-bins are made with slides, and located conveniently near the furnace and not too far from the kitchen stairs, with the partition so placed that coal can be thrown from the window into either bin. A storeroom is built with shelves, convenient to the cellar stairs. A laundry, with set tubs, is placed in the best lighted part of the cellar. A very desirable item frequently overlooked in planning, is to allow a space at the right-hand end of the laundry tubs for the clothes-basket. The laundry should also have a chimney near the laundry stove. There are also a basement toilet-room and an outside hatchway or rollway. The windows, as a rule, should be located under the windows in the upper story; and as the basement plan is frequently used on the work separately from the other plans, all dimensions should be given, so that no reference to the other plans will be necessary. The window openings may be figured to centers, but they are sometimes figured to the brick or stone opening. The heater, or hot-air furnace, is placed near the center of the cellar. The cold-air box should be arranged so as to take air from the side least affected by the changing winds (south or east). In the case here illustrated, it has been located under the front porch.

First-Floor Plan. This, the most important of all the working drawings (Fig. 29), shows at a glance the main proportions and dimensions of the whole building, besides being the plan of what, in our American manner of living, is the principal story of the house.

This house would be located to the best advantage on a lot facing

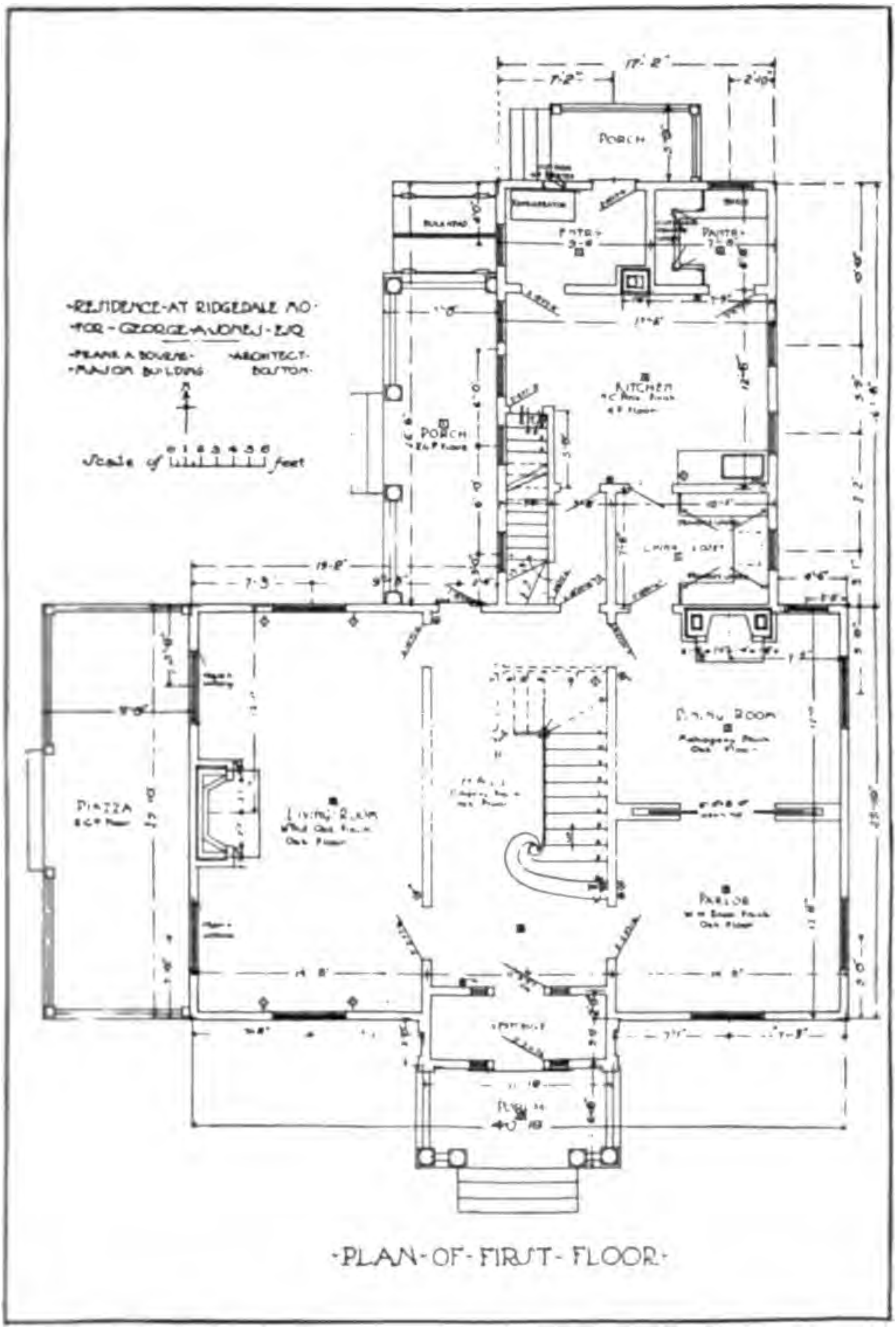

·RESIDENCE·AT RIDGEDALE MO·
·FOR·GEORGE·A·JONES·ESQ
·FRANK A BOURNE· ·ARCHITECT·
·MASON BUILDING· BOSTON·
N
Scale of 0 1 2 3 4 5 6 feet
17'-2"
7'-2"
2'-10"
PORCH
BULKHEAD
REFRIGERATOR
PANTRY
PANTRY
KITCHEN
PORCH
19'-8"
7'-3"
CHINA CLOSET
PIAZZA
LIVING ROOM
DINING ROOM
PARLOR
VESTIBULE
PORCH
·PLAN·OF·FIRST·FLOOR·

Fig. 29.

the south or southeast. This would put the kitchen on the north, the dining room on the east (which would give it the desirable mornng sun), and the parlor on the south and west.

The front porch sheltering the front doorway, and the vestibule and second door, form a protection necessary in cold northern climates. The hall and staircase in the center of the house open into the principal rooms. The living room on the left, 14 by 25 feet, opens by French windows on the piazza. The parlor to the right connects by sliding doors with the dining room. The living room and dining room both have open fireplaces.

From the rear of the hall a door opens on the rear porch, and another door leads to the passage connecting with the kitchen and the back stairs. Between the dining room and the kitchen is a large china closet, having glazed shelving and also a counter shelf on which is dotted the location for a china-closet sink—which, shown in this way, would not be considered a part of a contract, but could be put in later. From the kitchen a staircase leads down to the basement. The kitchen has windows on both sides, giving a cross-draft for ventilation, which is very agreeable in summer.

In the rear of the kitchen is a pantry, with cupboards, drawers, and shelving. The large back entry is planned for a refrigerator, which has an ice door on the rear, to be put in according to the directions furnished by the refrigerator maker.

This plan should be laid out like all the others, from a center axis, the dimensions being figured to outside of studs for outside walls, and to the center of partitions for inside walls, and to the centers of the window openings.

The sill line is ⅞ inch inside the outside line of the walls shown, while the inner line representing the plaster surface is 4¾ or 4⅞ inches inside the sill line. The dimensions being given in this way, it is a simple matter for the carpenter on the building to run his measuring stick between the outside studding and against the outside boarding, and to measure across, thus locating the center of an interior partition or the center of one of the windows. The location of gas and electric fixtures is shown by circles on the plans.

Second-Floor Plan. This is shown in Fig. 30. Only those dimensions are given on these plans which are not indicated on the first floor, as all second-floor partitions are supposed to rest on the

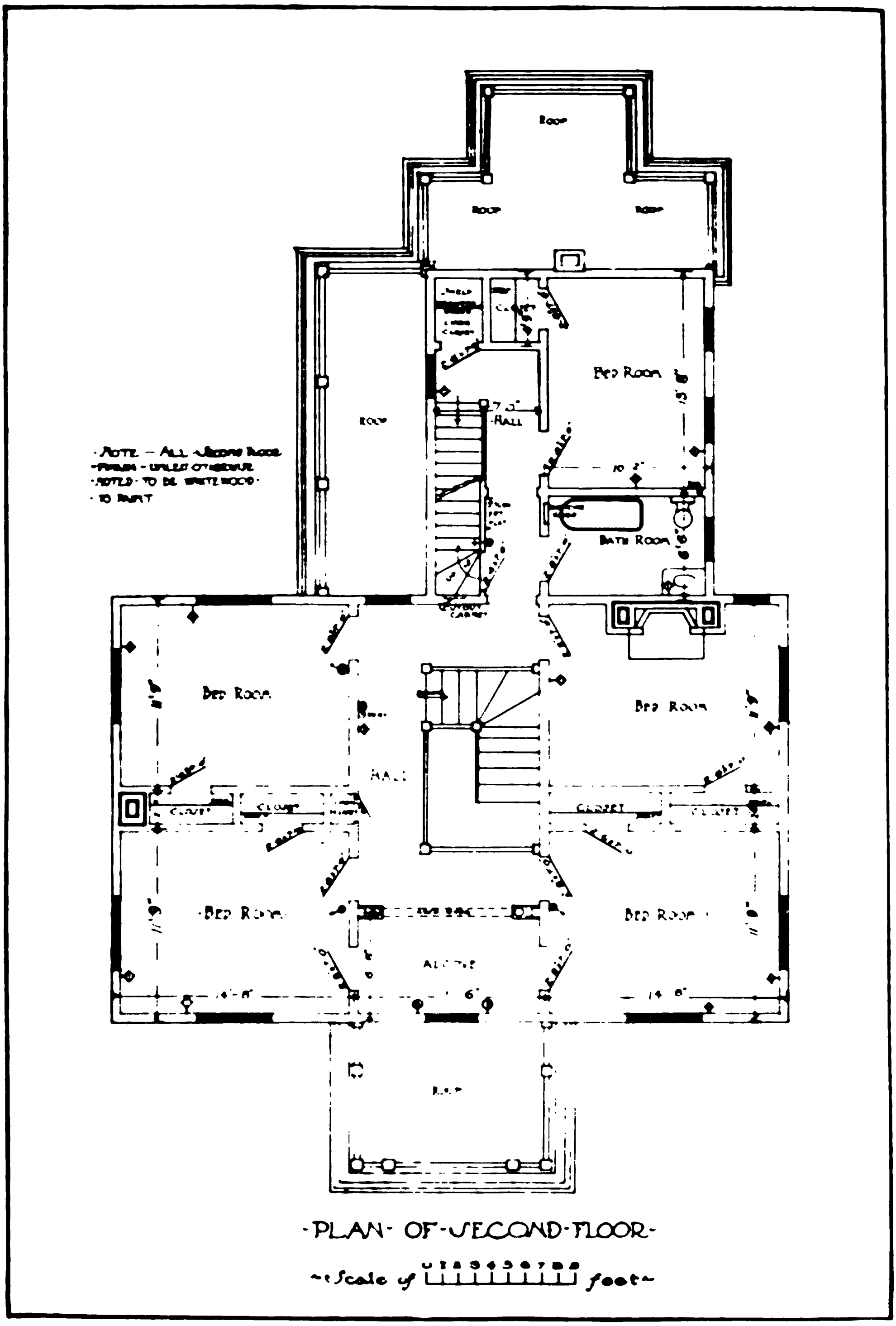
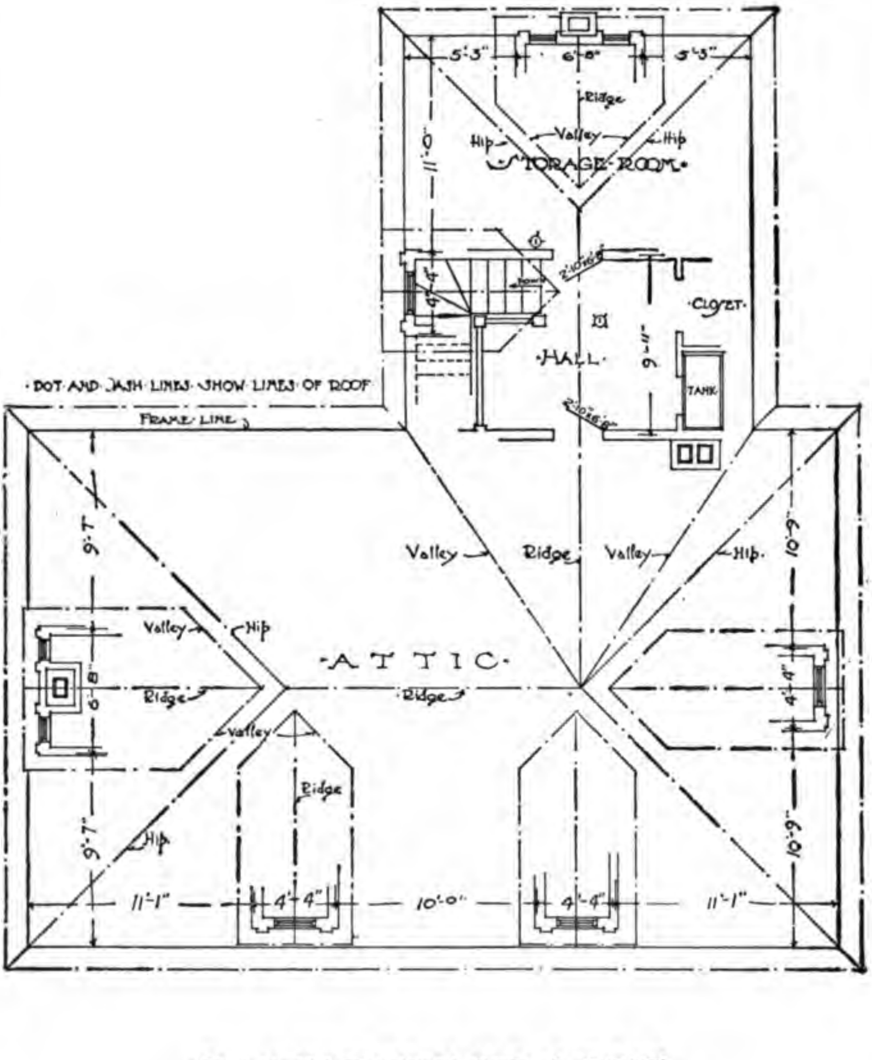
ROOF
ROOF
ROOF
ROOF
BED ROOM
15' 6"
7' 0"
HALL
10' 2"
BATH ROOM
6' 6"
CLOSET
·NOTE — ALL SECOND FLOOR
·FINISH — UNLESS OTHERWISE
·NOTED · TO BE WHITEWOOD ·
· TO PAINT
BED ROOM
11' 9"
BED ROOM
11' 9"
HALL
CLOSET
CLOSET
CLOSET
CLOSET
BED ROOM
11' 9"
BED ROOM
11' 6"
ALCOVE
14' 6"
6'
14' 6"
ROOF
·PLAN· OF·SECOND·FLOOR·
~Scale of 0 1 2 3 4 5 6 7 8 9 feet~

Fig. 30.



PLAN OF THIRD FLOOR & ROOF

Scale of 0 1 2 3 4 5 6 7 8 feet

Fig 31.

partitions below, if possible. The roofs of the porch and piazza are shown. These may be covered with painted canvas or with tin, and, if they are to be much used, should be provided also with a floor of wood slats. The staircase and hall are shown with an alcove opening toward the front, lighted from the window over the front porch. This alcove is separated from the hall by an arch resting on small columns, making an attractive sitting room. There are doors from it into the adjacent bedrooms. Instead of the arched opening, a partition may be put in, making a convenient dressing room. The bedrooms are 11 by 14 feet, and are provided with closets.

One bedroom has a fireplace, and the two bedrooms on the left of the house have access to a chimney. There is a small linen closet, provided with wide shelves, opening out of the hall. Sometimes the lower part of this closet is provided with drawers, and the upper part with wide lockers having drop fronts. The opening between the front hall and the rear hall can be closed with a door, if desired; or the door can be placed opposite the partition between the bathroom and the rear bedroom. The bathroom comes directly over the butler's pantry, so that the plumbing is all very compactly arranged. The staircase to the attic goes up over the back stairs that lead down to the kitchen. The rear bedroom, which could be used as a servants' room, is provided with a large closet. A large linen closet, with shelves and drawers, opens into the rear hall.

Attic and Roof Plan. The attic, as shown in Fig. 31, is left unfinished, with the exception of the hall at the top of the back stairs. The location of the tank is shown near a chimney, and a small closet opens off the hall. The roof lines are shown by dot-and-dash lines, which are frequently drawn in red on the working drawings. The frame line (*i. e.*, the line of the outside of the sill and the studding)—which should appear on all the working drawings—is shown here in full, with all dimensions noted thereon.

Front and Side Elevations. As shown in Figs. 32 and 33, the character of the house is "Colonial," of about the period of the beginning of the nineteenth century. The treatment is very simple and the details should be worked out delicately to obtain the Colonial character. The construction is comparatively simple, the base being of brick, sometimes with a granite course at grade, and sometimes the whole underpinning being of split granite. The wall is covered with

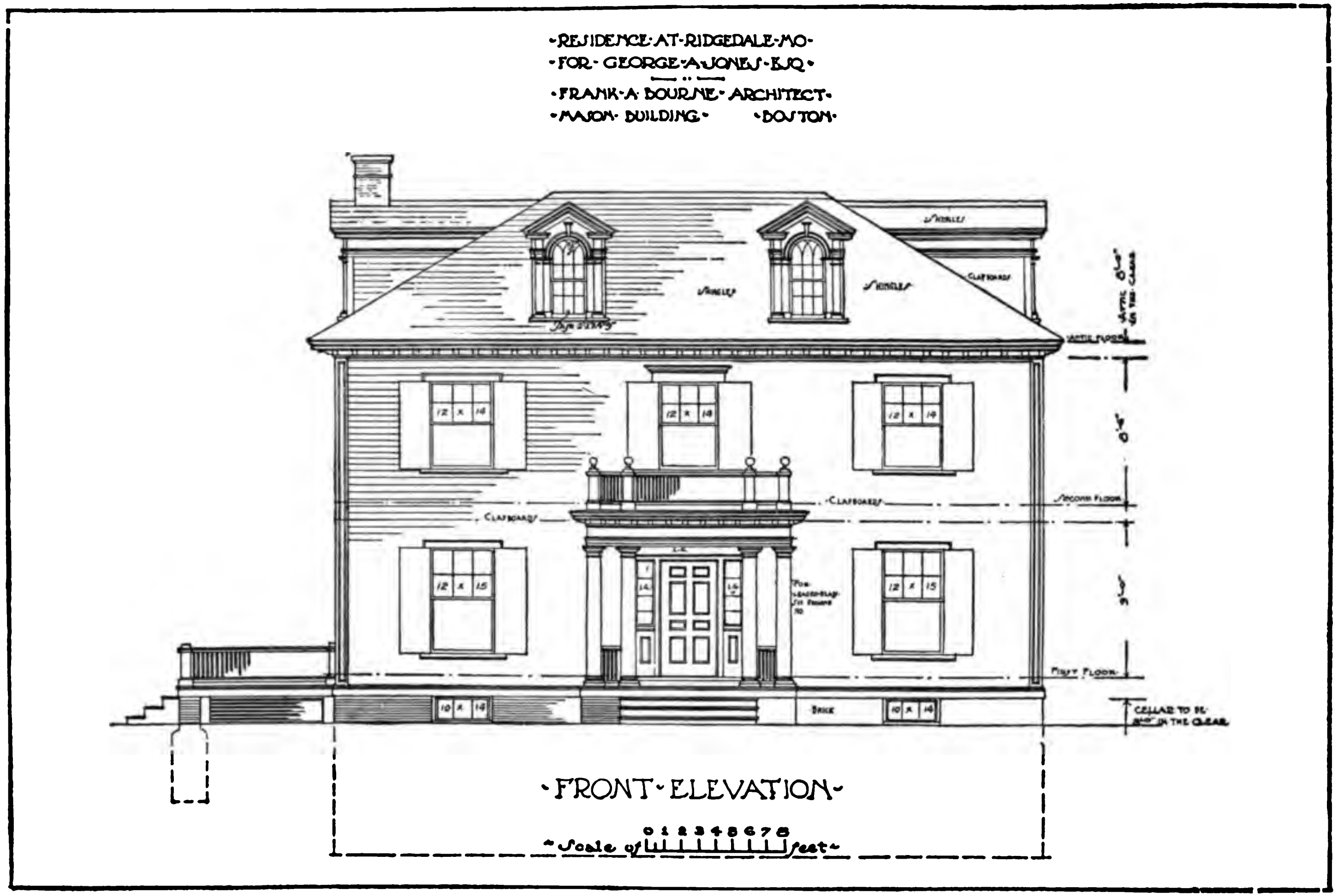

·RESIDENCE·AT·RIDGEDALE·MO·
·FOR·GEORGE·A·JONES·ESQ·
·FRANK·A·BOURNE·ARCHITECT·
·MASON·BUILDING·
·BOSTON·
Shingles
Shingles
Shingles
Clapboards
Clapboards
Clapboards
Attic Floor
Attic 8'-0" in the Clear
9'-0"
Second Floor
9'-6"
First Floor
Cellar to be 8'-0" in the Clear
12 x 14
12 x 14
12 x 14
12 x 15
12 x 15
14
14
10 x 14
10 x 14
Brick
·FRONT·ELEVATION·
0 1 2 3 4 5 6 7 8
Scale of feet

Fig. 32.

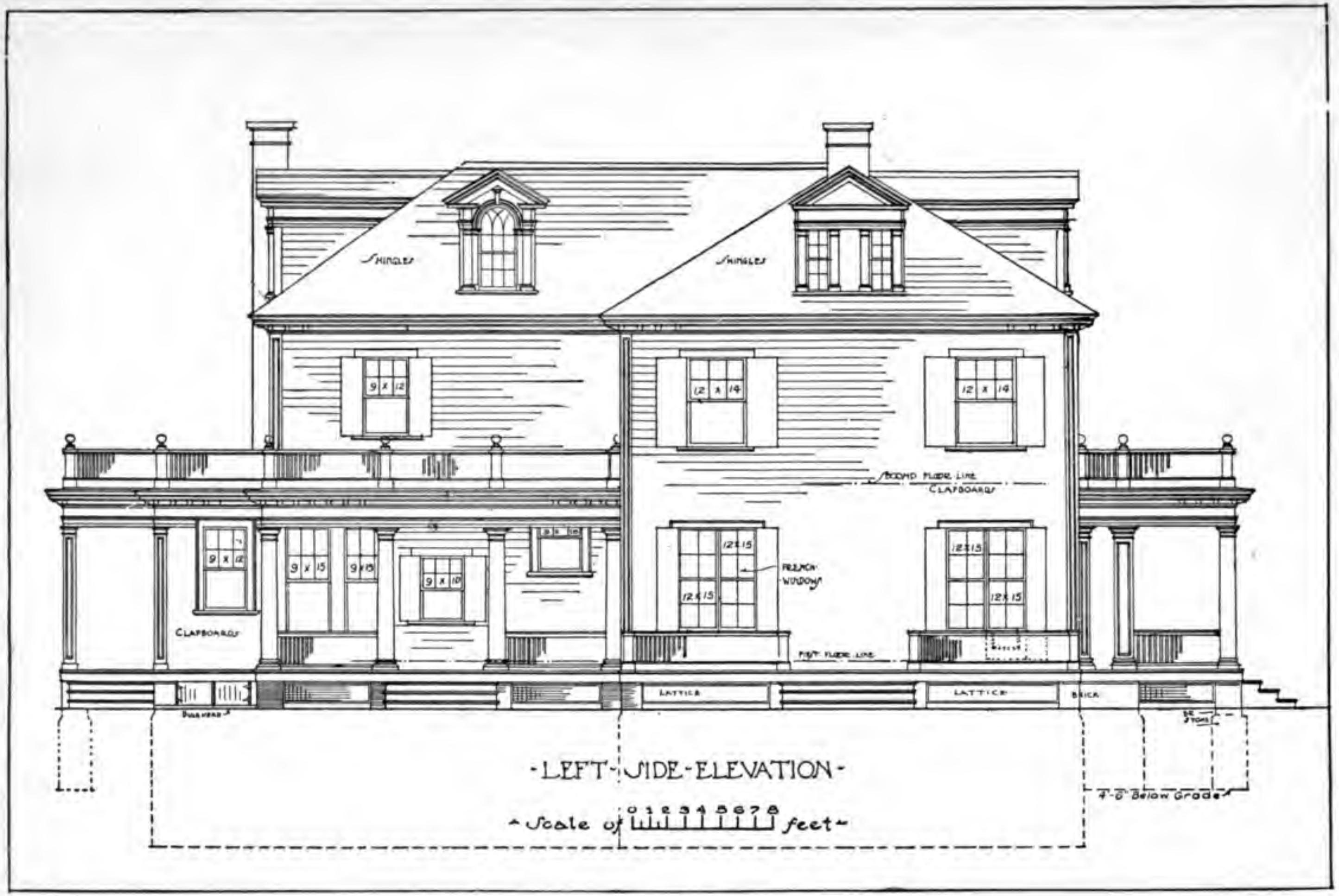

SHINGLES
SHINGLES
9 x 12
12 x 14
12 x 14
SECOND FLOOR LINE
CLAPBOARDS
9 x 12
9 x 15
9 x 15
9 x 10
12 x 15
12 x 15
12 x 15
12 x 15
FRENCH WINDOWS
FIRST FLOOR LINE
CLAPBOARDS
BULKHEAD
LATTICE
LATTICE
BRICK
16" STONE
4'-0" Below Grade
-LEFT-SIDE-ELEVATION-
-Scale of 0 1 2 3 4 5 6 7 8 feet-

Fig. 33.

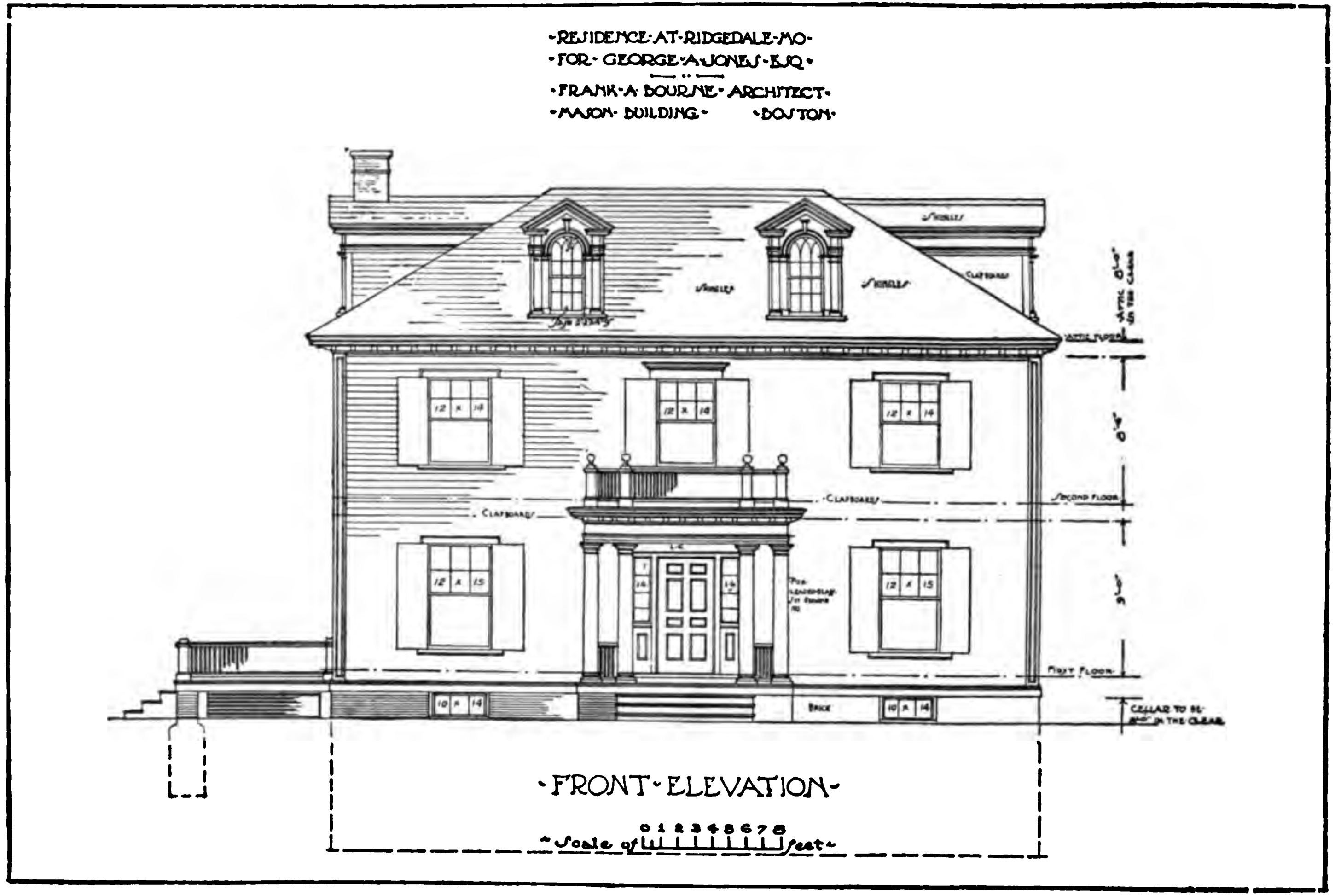

·RESIDENCE·AT·RIDGEDALE·MO·
·FOR·GEORGE·A·JONES·ESQ·
·FRANK·A·BOURNE·ARCHITECT·
·MASON·BUILDING· ·BOSTON·
Shingles
Shingles
Shingles
Clapboards
Clapboards
Clapboards
12 x 14
12 x 18
12 x 14
12 x 15
12 x 15
14
14
10 x 14
10 x 14
Brick
Attic 8'-0" in the clear
Attic floor
9'-0"
Second floor
9'-0"
First floor
Cellar to be 8'-0" in the clear
·FRONT·ELEVATION·
0 1 2 3 4 5 6 7 8
Scale of feet

Fig. 32.

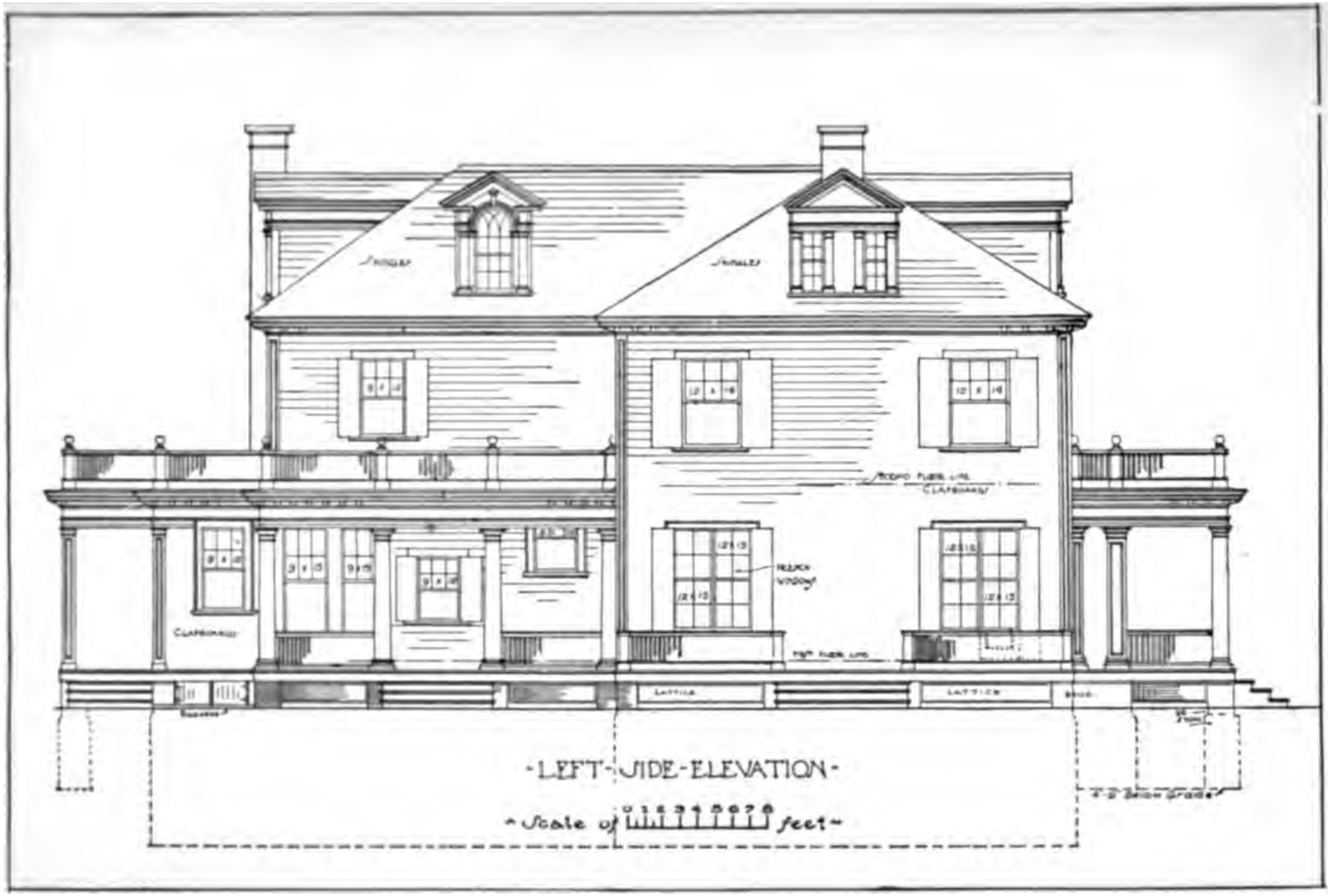

SHINGLES
SHINGLES
9 x 14
12 x 14
12 x 14
SECOND FLOOR LINE
CLAPBOARD
9 x 12
9 x 15
9 x 15
9 x 12
CLAPBOARD
12 x 13
FRENCH WINDOWS
12 x 13
12 x 13
12 x 13
FIRST FLOOR LINE
LATTICE
LATTICE
BRICK
4'-0" Below Grade
-LEFT-SIDE-ELEVATION-
-Scale of 0 1 2 3 4 5 6 7 8 feet-

Fig. 33.

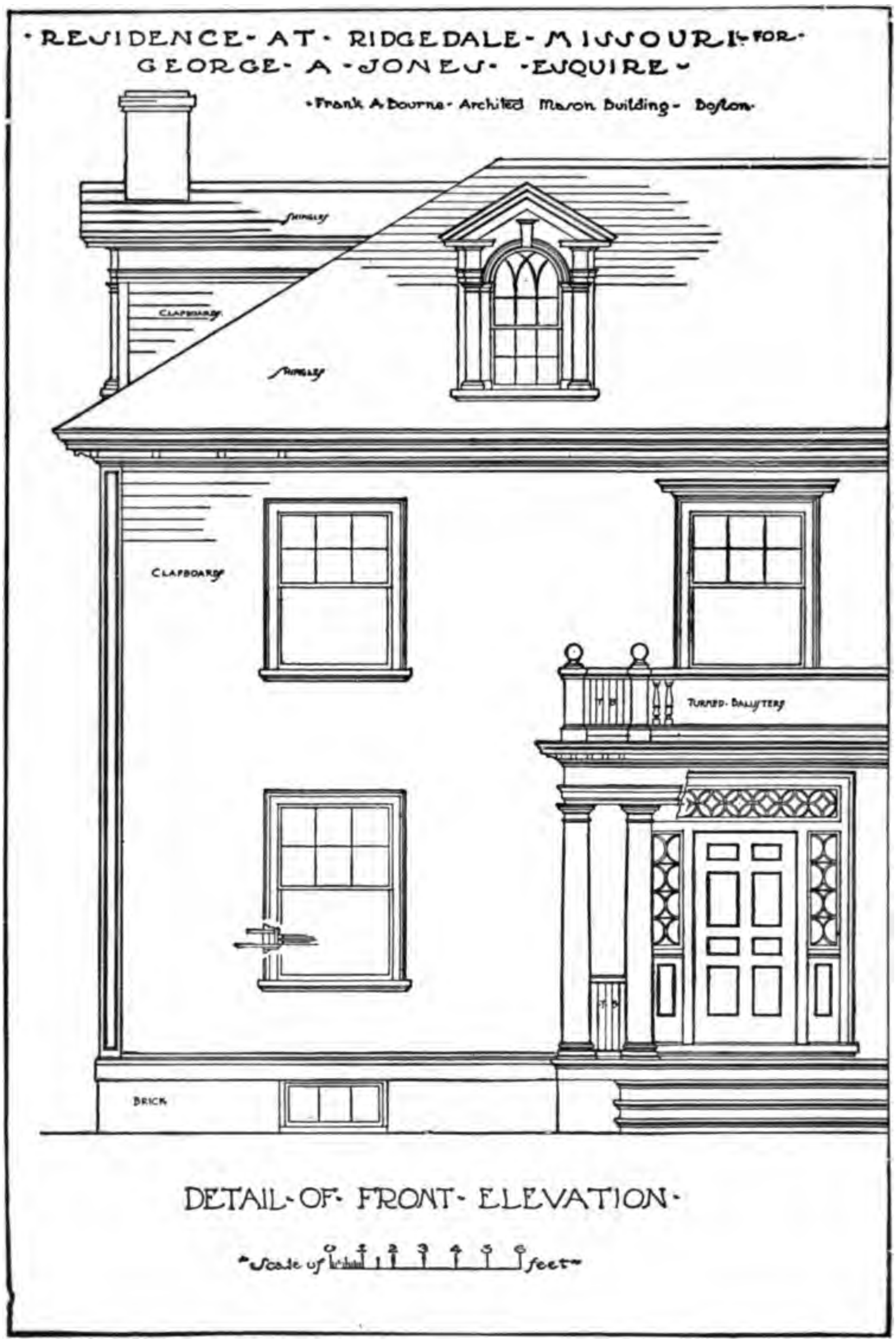

RESIDENCE AT RIDGEDALE MISSOURI FOR
GEORGE A JONES ESQUIRE
Frank A. Bourne - Architect Mason Building - Boston
SHINGLES
CLAPBOARDS
SHINGLES
CLAPBOARDS
TURNED BALUSTERS
BRICK
DETAIL OF FRONT ELEVATION
Scale of 0 1 2 3 4 5 6 feet

Fig. 34.

tablature is used. The dormer shows a peculiar Colonial treatment, using a small Doric Order on each side of the arched window. The muntins of the sash are generally worked out in wood. At the side of the roof is shown a side elevation of the dormer.

First-Floor Framing Plan. (Fig. 35.) The supports shown with a dot-and-dash line would usually be shown in red ink in the working drawings. The sill, 6 by 8 inches, laid flat, is shown with a full line running all around the building. The girders and the posts on which they rest are shown in a full line, the girders being 8 inches by 10 inches, and the posts not over 10 feet apart. The piazza girders are 4 by 6, and the piazza sills are 4 by 6. The piazza floor joists are 2 by 8 inches, 20 inches on center. The dimensions are given to the outside of the sill, and to the centers of the partitions. Where the partitions come over each other and are parallel to the joists, a joist is set 1 inch each side of the studs of the partition, so that the rough floor boards may run directly through and leave room for nailing for the finished floor each side of the partitions. Trimmers and headers are double the size of their respective floor joists, being 4 by 10 inches in this case. All joists are set 2 inches clear of the fireplace openings. The distances are given to the centers of the trimmers, but sometimes dimensions are given for the clear opening. All the first-floor joists are to be 2 by 10, placed 16 inches on centers. The bridging is shown dotted. This is made of 1 by 2½-inch stock set diagonally between the joists.

It will be noticed that all the 2-inch joists except those in special locations—for example, under a partition, as above mentioned—are shown with only a single line, all other timbers being shown with a double line.

Second-Floor Framing Plan. The second-floor framing plan (Fig. 36) is similar to the first-floor, the girts, 4 by 6 inches, being shown instead of the sill. The framing of the roofs of the porches is shown, and notes are made where the girts are flush or where they are sunk. In certain cases it will be noticed that the joists are carried through, continuous. It often happens that shorter stock might have been used at no disadvantage to the building. The joists across the building should be nailed together wherever possible, so as to make a complete tie across the building.

Attic Framing Plan. On this drawing (Fig. 37), the roof plate is shown, and also the location of the hard pine ledger-board. The

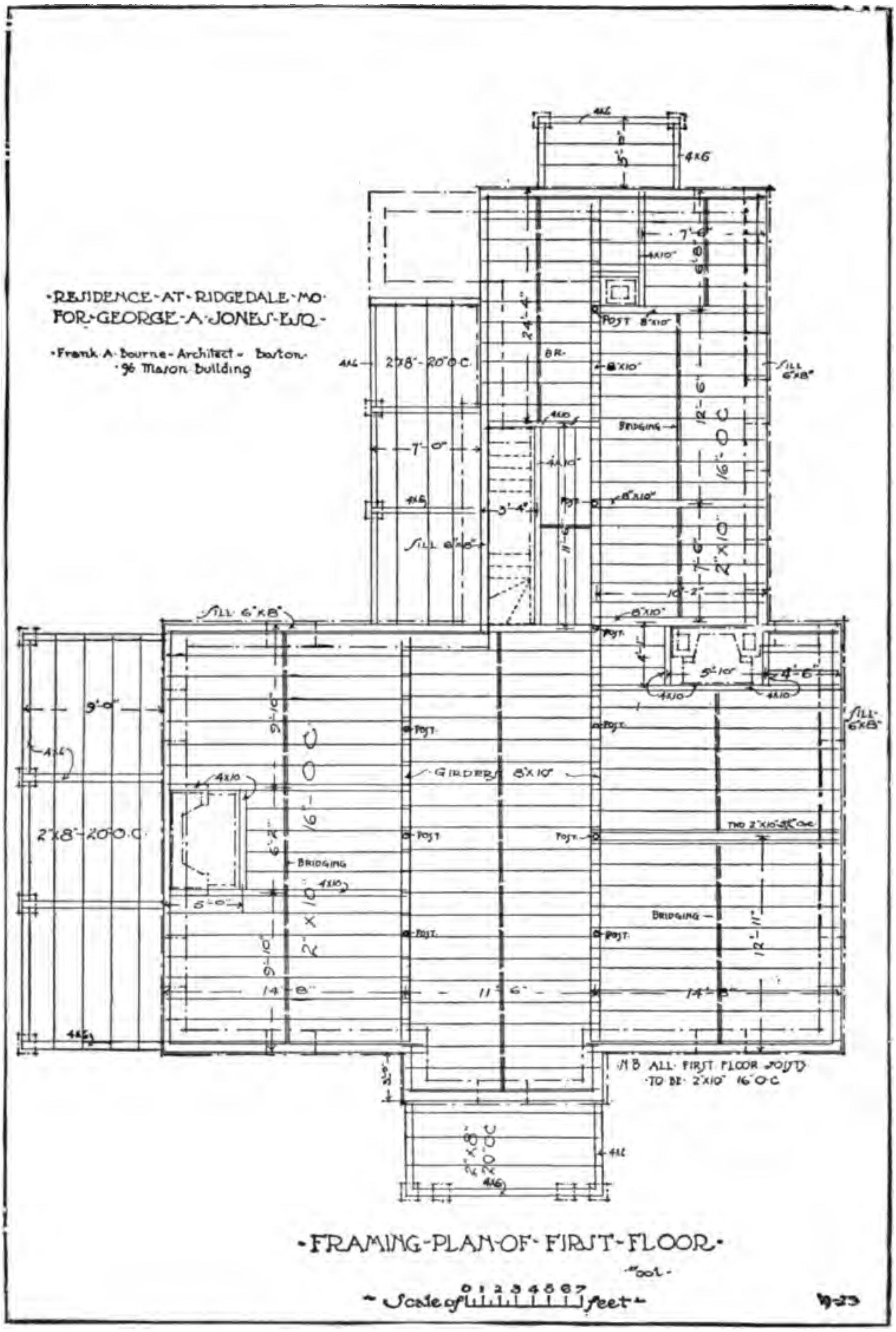
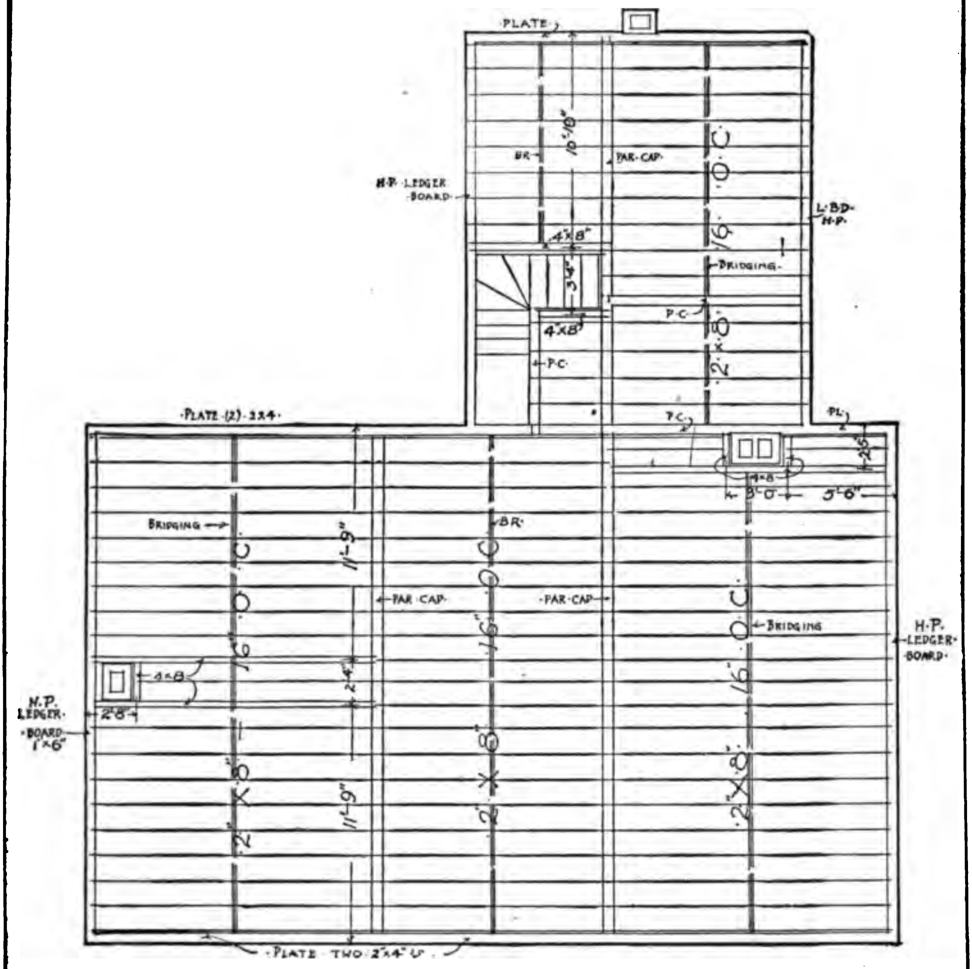

·RESIDENCE·AT·RIDGEDALE·MO·
FOR·GEORGE·A·JONES·ESQ·
·Frank·A·Bourne·Architect· Boston·
·96 Mason Building
4x6
5'
4x6
7'-6"
4x10"
6'-8"
POST 8"x10"
24'-4"
BR.
8"x10"
SILL 6"x8"
4x6
2"x8"-20"O.C.
4x10
BRIDGING
12'-6"
16"O C
7'-0"
4x10"
4x6
3'-4"
POST
8"x10"
SILL 6"x8"
11'-6"
7'-6"
2"x10"
10'-2"
SILL 6"x8"
8"x10"
POST
4'
5'-10"
4'-6"
4x10
4x10
SILL 6"x8"
9'-0"
4x6
POST
POST
GIRDERS 8"x10"
4x10
2"x8"-20"O.C
9'-10"
16"-O C
6'-2"
2"x10"
BRIDGING
4x10
5'-0"
POST
POST
TWO 2"x10"-8"O.C.
POST
POST
BRIDGING
12'-11"
9'-10"
14'-8"
11'-6"
14'-8"
4x6
N.B. ALL FIRST FLOOR JOISTS
TO BE 2"x10" 16"O.C.
3'-0"
2"x8"-20"O.C
4x6
4x6
·FRAMING·PLAN·OF·FIRST·FLOOR·
#001
0 1 2 3 4 5 6 7
Scale of feet
13-23

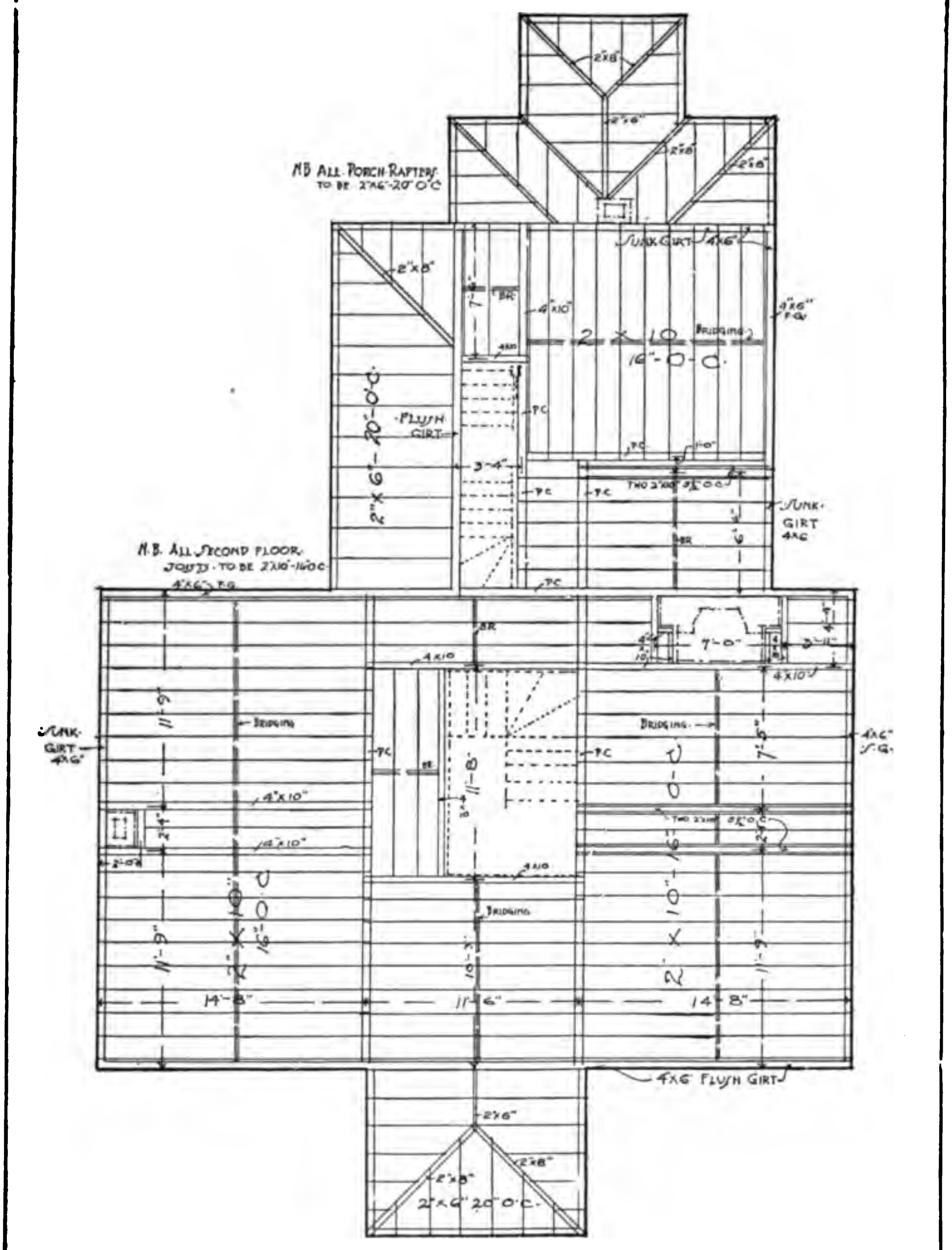
Fig. 35.



·FRAMING·PLAN·OF·THIRD·FLOOR·

Scale of 0 1 2 3 4 5 6 7 8 feet

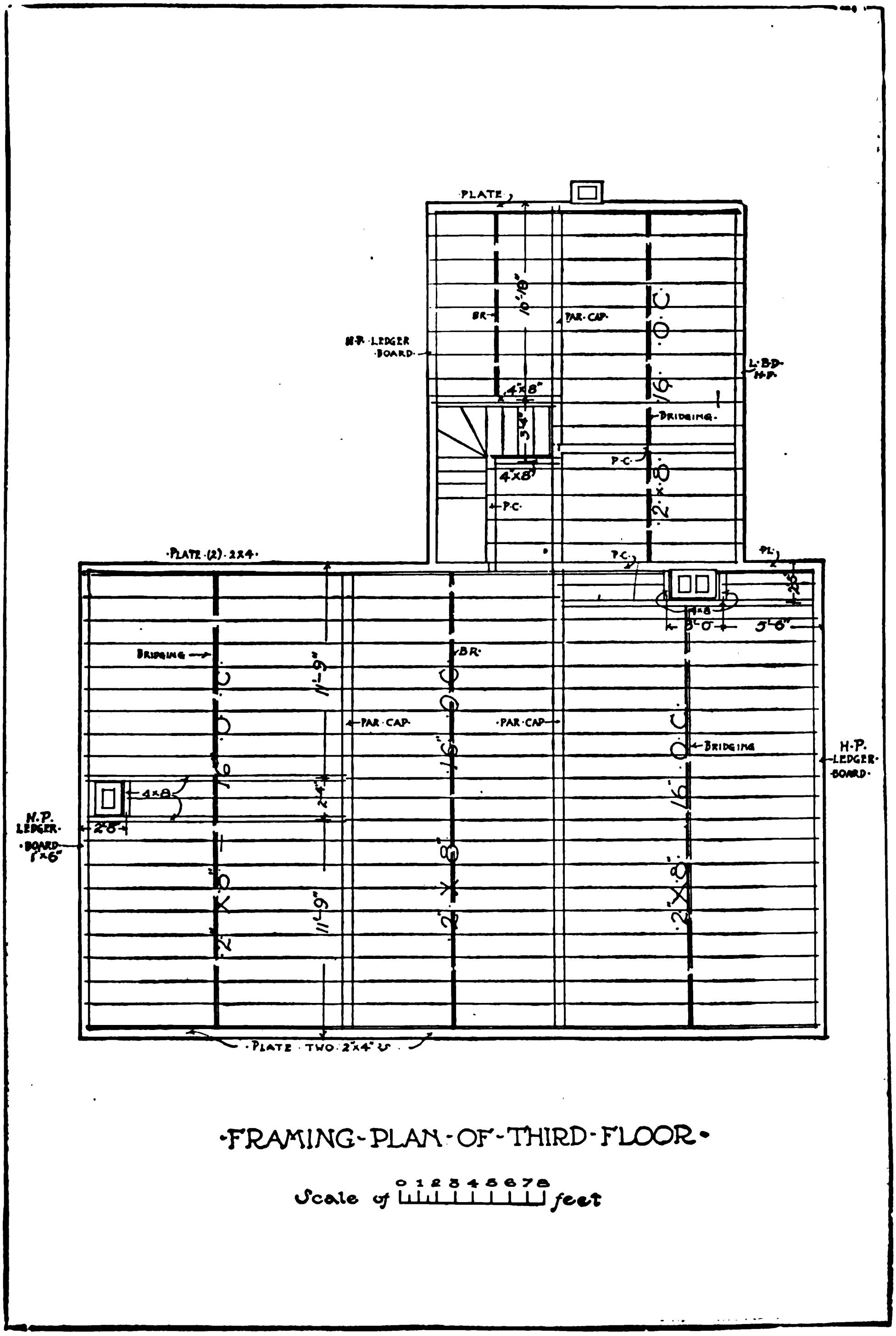
Fig. 37.



-FRAMING-PLAN-OF-SECOND-FLOOR-

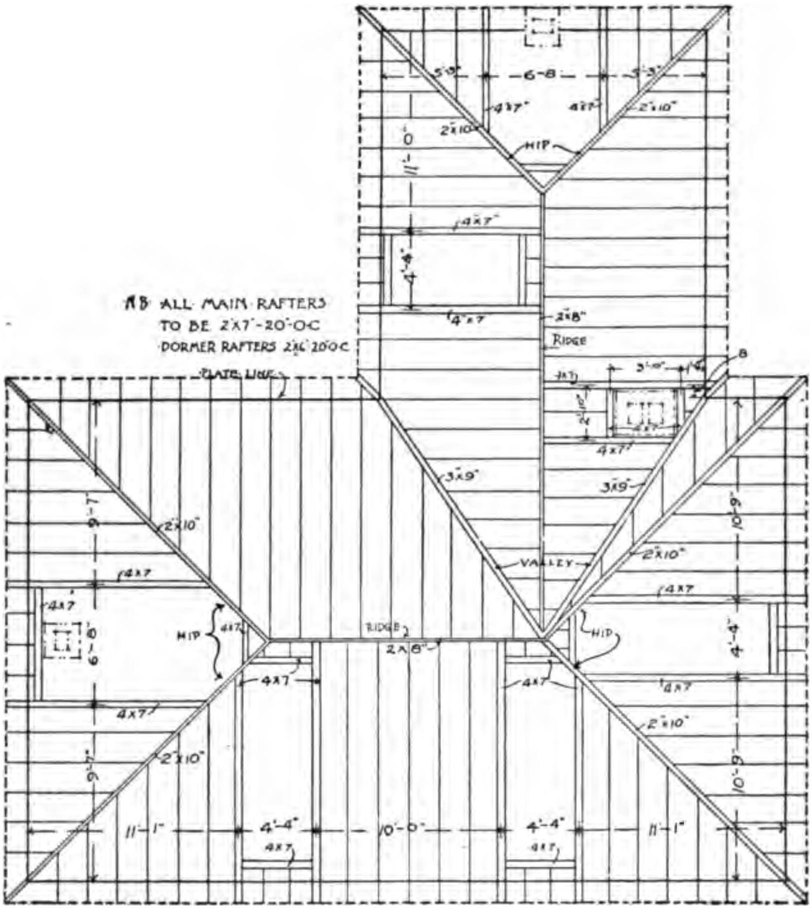
Scale of 0 1 2 3 4 5 6 feet

Fig. 36.



·FRAMING·PLAN·OF·THIRD·FLOOR·

Fig. 37.



-FRAMING-PLAN-OF-ROOF-

-Scale of 0 1 2 3 4 5 6 7 8 feet.-

Fig. 38.

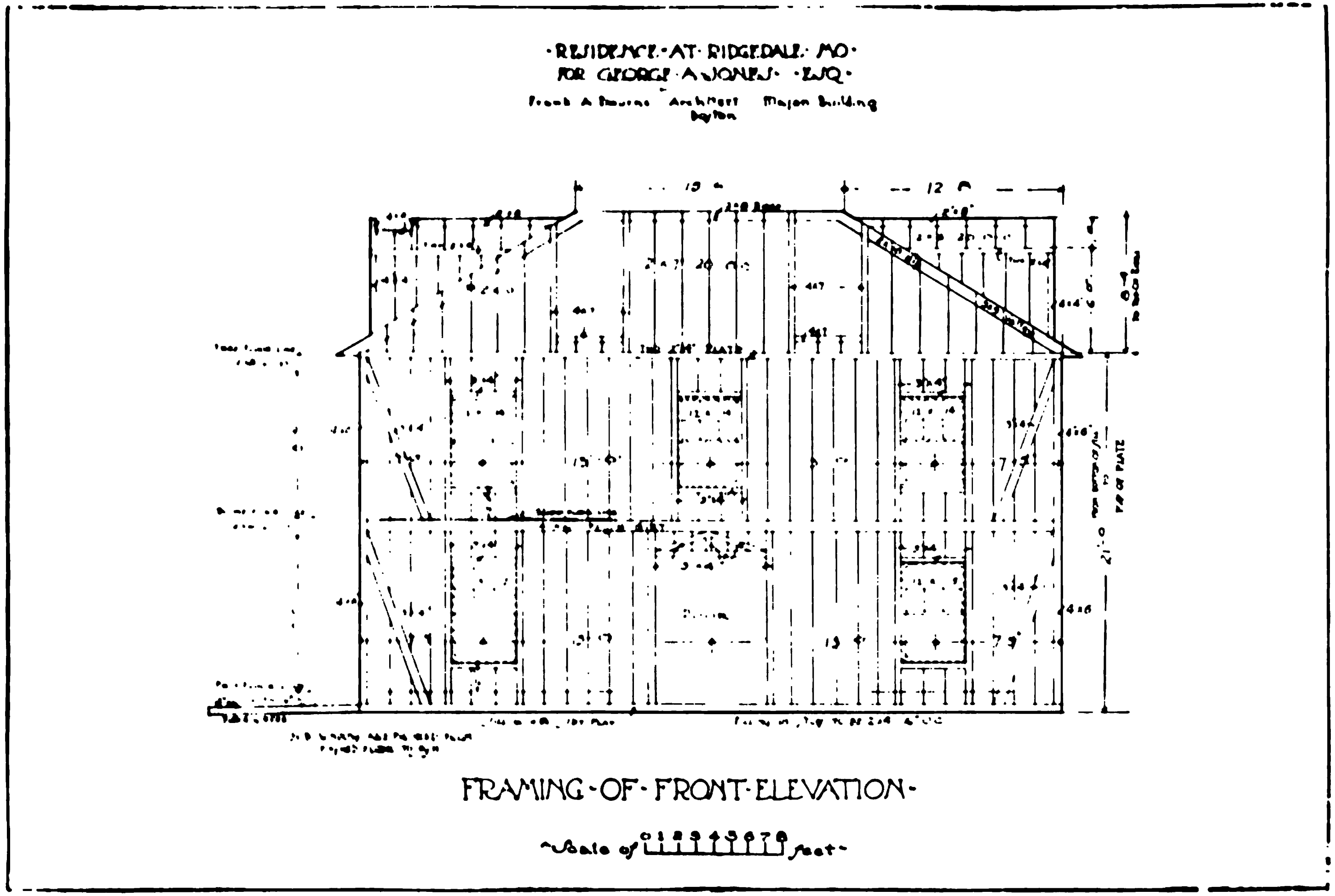
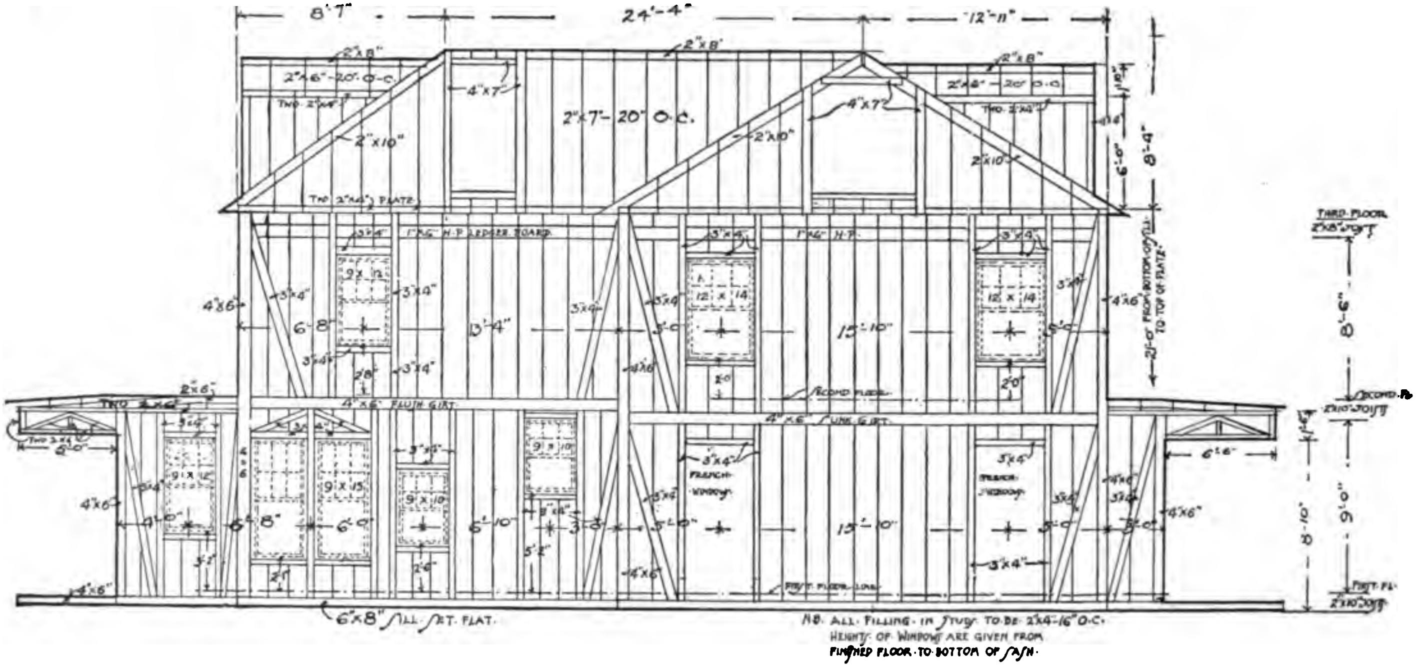

·RESIDENCE·AT·RIDGEDALE·MO·
FOR GEORGE·A·JONES·ESQ·
Frank A Bourne Architect Major Building Dayton
15'-0"
12'-0"
21'-0"
4x6
FRAMING·OF·FRONT·ELEVATION·
Scale of 0 1 2 3 4 5 6 7 8 feet

Fig. 30



N.B. ALL FILLING-IN STUDS TO BE 2"x4"-16" O.C.
HEIGHTS OF WINDOWS ARE GIVEN FROM FINISHED FLOOR TO BOTTOM OF SASH.

·FRAMING·OF·LEFT·SIDE·ELEVATION·

~Scale of 0 1 2 3 4 5 6 7 8 9 feet~

Fig. 40

partition caps of the story below, on which the joists rest, are shown. The joists in the attic floor are 2 by 8, placed 16 inches on centers.

Roof Framing Plan. The rafters and hips are shown (Fig. 38) 2 by 10; the valley rafters, 3 by 9; the ridge, 2 by 8 inches. The rafters either side of the dormer openings are 4 by 7, and the headers for the dormers are also 4 by 7 inches. All the other main rafters are 2 by 7 inches, placed 20 inches on centers; and the dormer rafters, 2 by 6, placed 20 inches on centers. The plate line, which is the same as the first-floor sill line, is shown as a full line, and the dimensions are given from this line.

Framing of Front Elevation. The framing of the front elevation of the house above the foundation is shown in Fig. 39. The sill is 6 by 8, resting on its 8-inch face. The corner posts are 4 by 6, framed into the sill; and a 4 by 6 flush girt is shown running around the house. It will be noticed that the girt stops on the side elevations where it is marked "4 by 6 sunk girt" (Fig. 40). The plate is formed of 2 by 4 joists, which break joints all around the building. The frame is braced by 3 by 4 studs, these braces being as long as possible, which is considered better construction than the former short-brace system. In cheaper work, 2 by 4 braces, halved into the studding, are sometimes used in the same position. The filling-in studs are 2 by 4, set 16 inches on centers. The door and window studs are 3 by 4 inches, set 5 inches clear of the sash opening.

The dimensions are given to the centers of the openings. The heights are generally given to the finished floor, which would be 2 inches above the joist line. The large openings are trussed, as shown over the front door opening. The rafters are 2 by 7, set 20 inches on centers, the hips being 2 by 10, and the valley rafters 3 by 4. The dormers are built up of 4 by 4 corner posts and 4 by 7 rafters each side of the opening. The ridge is 2 by 8, the distance to the top of ridge being given above the top of the plate, and all the points on the ridge rafters and ridge may be located on the sill line to the junction of the hip.

Framing of Side Elevation. The sill, girts, corner posts, studding, plate, and rafters (Fig. 40), are similar to those already described on the front elevation. The framing of the front and rear porches is also shown, with the dimensions given similarly. The attic floor joists

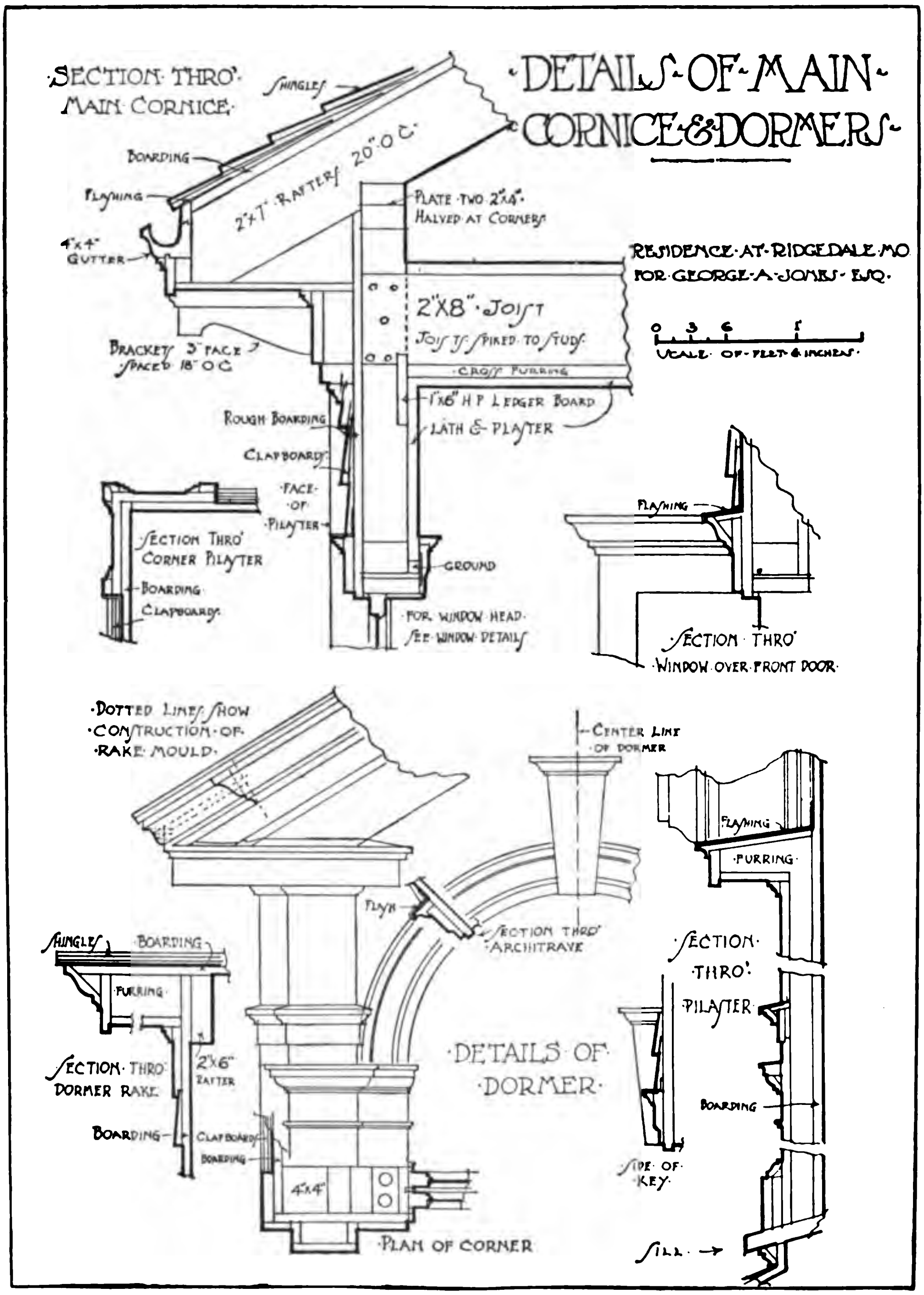

DETAILS OF MAIN CORNICE & DORMERS
RESIDENCE AT RIDGEDALE MO FOR GEORGE A JONES ESQ
0 3 6 1'
SCALE OF FEET & INCHES
SECTION THRO' MAIN CORNICE
SHINGLES
BOARDING
FLASHING
4"x4" GUTTER
2"x7" RAFTERS 20" O C
PLATE TWO 2"x4" HALVED AT CORNERS
2"X8" JOIST
JOISTS SPIKED TO STUDS
CROSS FURRING
1"x6" H P LEDGER BOARD
LATH & PLASTER
BRACKETS 3" FACE SPACED 18" O C
ROUGH BOARDING
CLAPBOARDS
FACE OF PILASTER
GROUND
FOR WINDOW HEAD SEE WINDOW DETAILS
SECTION THRO' CORNER PILASTER
BOARDING
CLAPBOARDS
FLASHING
SECTION THRO' WINDOW OVER FRONT DOOR
DOTTED LINES SHOW CONSTRUCTION OF RAKE MOULD
CENTER LINE OF DORMER
FLASH
SECTION THRO' ARCHITRAVE
SHINGLES
BOARDING
FURRING
SECTION THRO' DORMER RAKE
2"X6" RAFTER
BOARDING
CLAPBOARDS
BOARDING
4"x4"
PLAN OF CORNER
DETAILS OF DORMER
FLASHING
FURRING
SECTION THRO' PILASTER
BOARDING
SIDE OF KEY
SILL

Fig. 41.

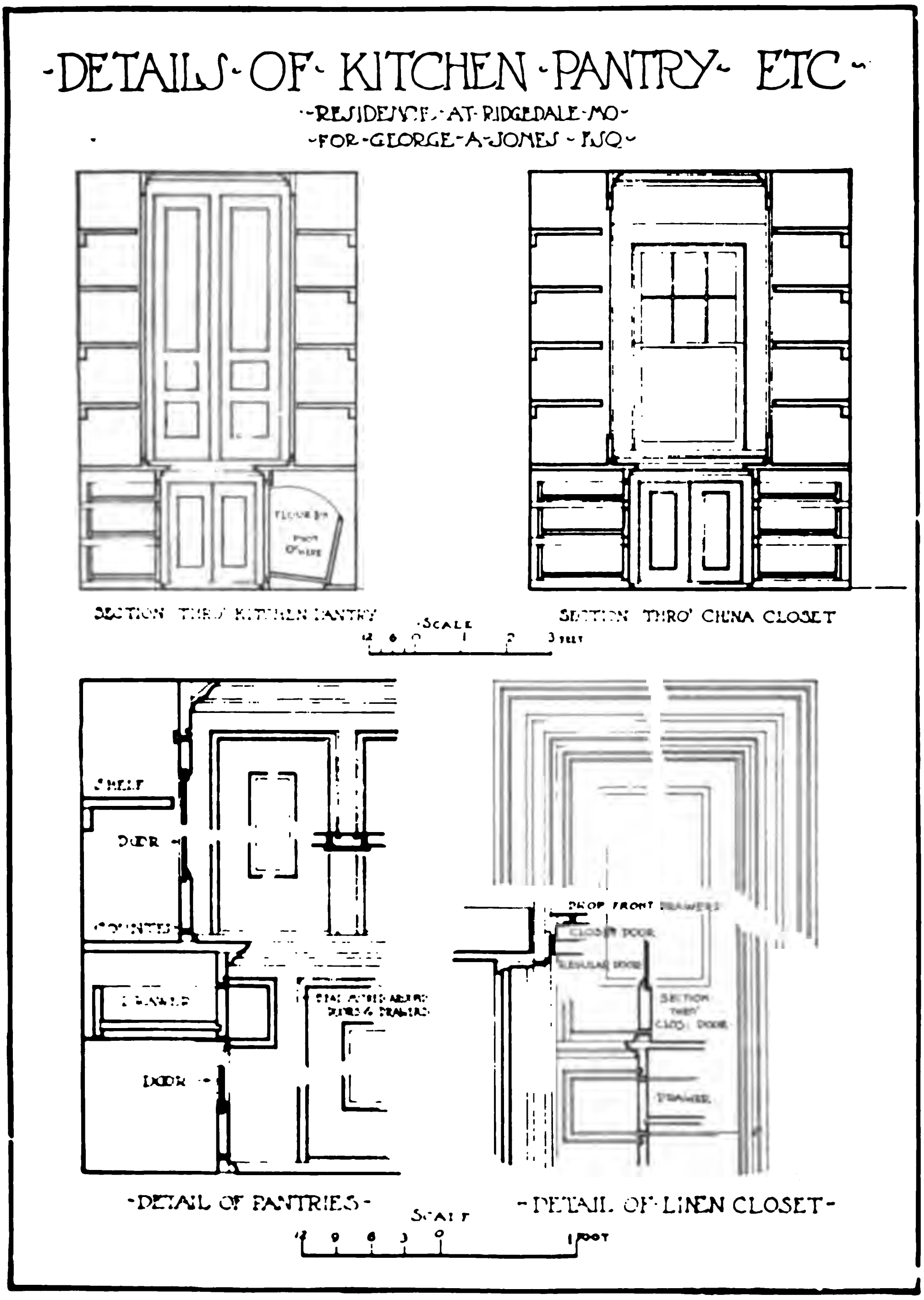

-DETAILS-OF-KITCHEN-PANTRY-ETC-
-RESIDENCE-AT-RIDGEDALE-MO-
-FOR-GEORGE-A-JONES-ESQ-
FLOUR BIN
SECTION THRO' KITCHEN PANTRY
SECTION THRO' CHINA CLOSET
SCALE
12 6 0 1 2 3 FEET
SHELF
DOOR
COUNTER
DRAWER
DOOR
DOORS & DRAWERS
DROP FRONT DRAWERS
CLOSET DOOR
REGULAR DOOR
SECTION THRO' CLOS. DOOR
DRAWER
-DETAIL OF PANTRIES-
-DETAIL OF LINEN CLOSET-
SCALE
12 9 6 3 0 1 FOOT

Fig. 42

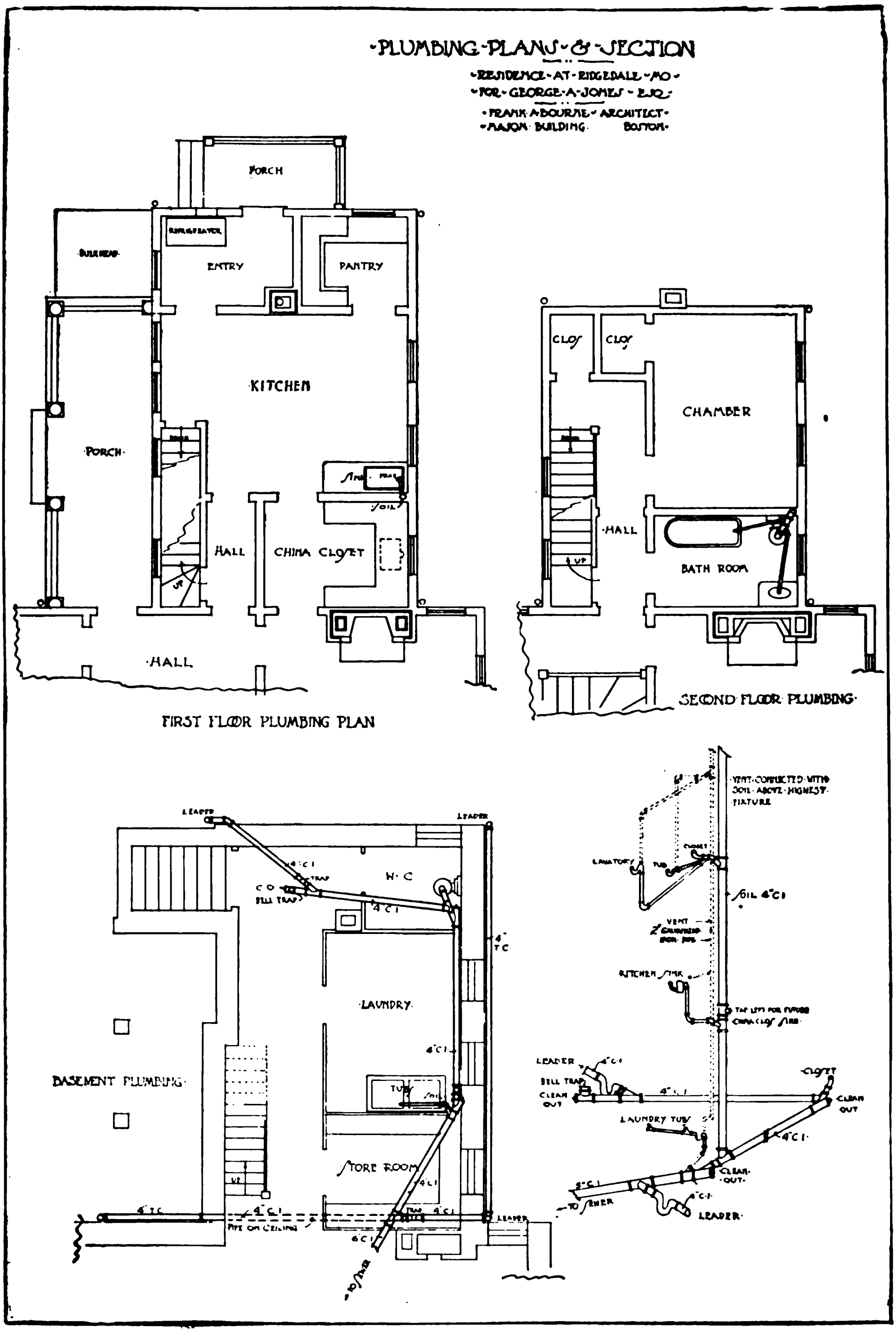

·PLUMBING·PLANS·&·SECTION
·RESIDENCE·AT·RIDGEDALE·MO·
·FOR·GEORGE·A·JONES·ESQ·
·FRANK·A·BOURNE·ARCHITECT·
·MASON·BUILDING· BOSTON·
PORCH
BULKHEAD
REFRIGERATOR
ENTRY
PANTRY
KITCHEN
·PORCH·
SINK
TRAP
SOIL
HALL
CHINA CLOSET
·HALL
FIRST FLOOR PLUMBING PLAN
CLOS
CLOS
CHAMBER
·HALL
BATH ROOM
UP
SECOND FLOOR PLUMBING·
LEADER
LEADER
4" C I
TRAP
W·C
C O
BELL TRAP
4" C I
4" T C
·LAUNDRY·
4" C I
BASEMENT PLUMBING·
TUB
SINK
STORE ROOM
4" C I
UP
4" T C
4" C I
PIPE ON CEILING
TRAP
4" C I
LEADER
6" C I
TO SEWER
·VENT·CONNECTED·WITH·SOIL·ABOVE·HIGHEST·FIXTURE
CLOSET
LAVATORY
TUB
SOIL 4" C I
VENT
2" GALVANIZED IRON PIPE
KITCHEN SINK
TAP LEFT FOR FUTURE CHINA CLOSET SINK·
LEADER
4" C I
BELL TRAP
CLEAN OUT
4" C I
CLOSET
CLEAN OUT
LAUNDRY TUB
4" C I·
CLEAN·OUT·
5" C I
TO SEWER
4" C I·
LEADER·

Fig. 43.

are supported on a 1 by 6 hard pine ledger-board, which is cut into **the studding after** the manner of balloon framing.

Main Cornice and Dormer. Fig. 41 is reduced from a drawing made at a scale of three-fourths inch to the foot. This plate should be drawn out at the original scale mentioned; and a full-size pencil study should be made for comparison.

Kitchen, Pantry, and China Closet. Fig. 42 shows the details of kitchen, pantry, and china closet reduced from a drawing made at a scale of one-half inch to the foot, and larger details at a scale of one and one-half inches to the foot, showing shelving, lockers, and doors. These are all included in the interior finish, and should follow the specifications as to sizes. The mouldings should all be full-size.

Plumbing. Fig. 43 shows the plumbing details for this building, These details are carried somewhat further than is usually done on plans, but no further than advisable, as they will be found of great assistance in carrying out and superintending the work. The basement plan shows the direction of the sewer connection, which is a horizontal pipe, six inches in diameter, of cast iron, located either on the basement ceiling or in a trench on the cellar floor. In this case it must be below the cellar-floor level in order to take the laundry tubs. The section shows the elevations of the pipe carried up through the house. There will be a trap between the point shown and the sewer, just outside the wall of the house. The leader connections are 4-inch cast-iron pipe inside the house in cellar floor, and 4-inch terra-cotta outside the house, to take the water from the gutters and conductors. On the first connection there is a cleanout, and the size of the pipe is reduced from 6 inches to 4 inches. There should be cleanouts at every bend, and also at about every fifteen feet of horizontal run. There should be a bell trap (Fig. 44) to take the cellar surface water, also branches for general fixtures through the house, as shown. The vertical pipe of 4-inch cast iron would rest on a brick pier at the bottom built by the mason.

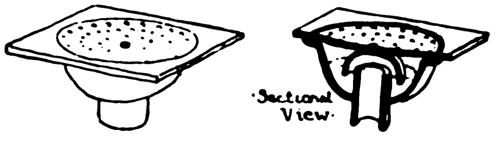


Fig. 44.

The vent pipes from the trap of every fixture are shown in dotted lines, and are carried up beyond the highest fixture, where they may be

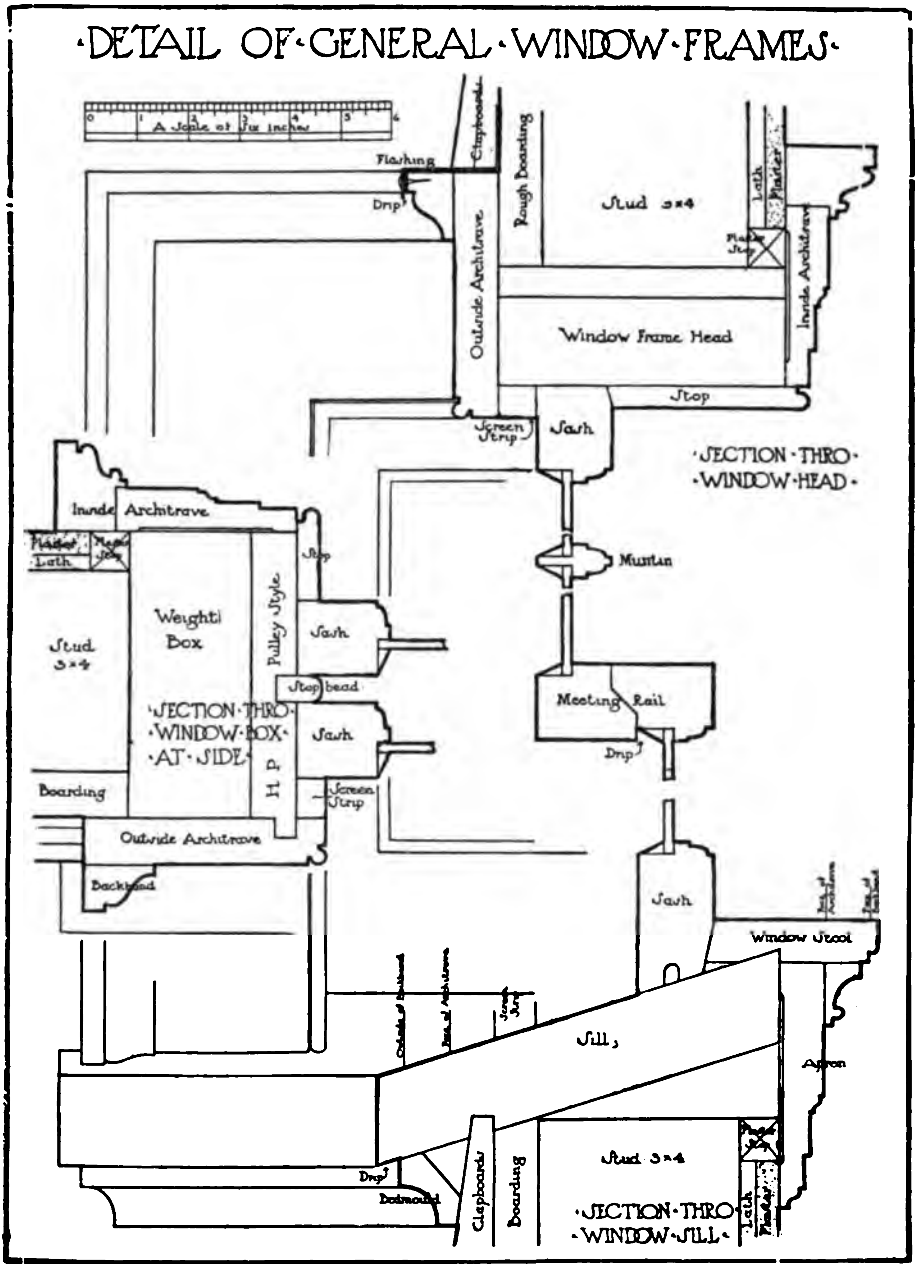
 ·DETAIL OF·GENERAL·WINDOW·FRAMES·
0 1 2 3 4 5 6
A Scale of Six inches
Flashing
Drip
Clapboards
Rough Boarding
Outside Architrave
Stud 3×4
Lath
Plaster
Plaster Stop
Inside Architrave
Window Frame Head
Stop
Screen Strip
Sash
·SECTION·THRO·
·WINDOW·HEAD·
Inside Architrave
Plaster
Plaster Stop
Lath
Stop
Muntin
Weights Box
Pulley Style
Stud 3×4
Sash
Stop bead
Meeting Rail
·SECTION·THRO·
·WINDOW·BOX·
·AT·SIDE·
Sash
Drip
H.P.
Boarding
Screen Strip
Outside Architrave
Backband
Sash
Face of Architrave
Face of Backband
Window Stool
Outside of Backband
Face of Architrave
Screen Strip
Sill
Apron
Plaster Stop
Stud 3×4
Drip
Bedmould
Clapboards
Boarding
·SECTION·THRO·
·WINDOW·SILL·
Lath
Plaster

Fig. 45.

carried back into the soil pipe or through the roof. Branches are taken off for the laundry tubs, china closet, sink, lavatory, tub, and closet, as shown in the section and on the first and second-floor plumbing plans. Sometimes these pipes are shown in blue on the regular working drawings; but there is an advantage in having them on a separate sheet, as has been done in this detail. The vent pipes from the traps may be of 2-inch cast iron or of 2-inch galvanized wrought iron. This practice varies with the building laws in different localities.

Detail of General Window Frames. Fig. 45 shows the method of laying out a full-size detail of a window box. Such a drawing is one of the first things usually given to a draftsman on entering an architect's office, and one of the most important details of house building to become acquainted with. The drawing shows an elevation of the lower left-hand corner and upper left-hand corner of the window-frames seen from the outside. The lower part of the drawing shows a section through the window sill. Taking the scale of 6 inches shown at the top of the drawing, it would be found that the window sill can be made from 2-inch stock finished about one and three-quarters inches thick. On the outside, next to the clapboards, is a bed-moulding, and the slope of the sill forms a good drip to throw off water. The clapboards are housed into the under side of the sill. The sill rests on a 3 by 4 or 4 by 4 horizontal stud under the window opening. The inner side of the sill is cut to come on a line with the finished plaster. The plaster stop or ground, which is either three-quarters or seven-eighths inch thick, according to the proposed thickness of the plaster, is nailed on to the 3 by 4 stud. The space between the stud and the sill is frequently filled with mortar. At the left of the drawing is shown a section through the side of the window box.

The outside architrave is arranged on the outside of the boarding; and a back band, or moulded strip, forms a finish around the outside edge. The layers of paper are generally run on the boarding under this outside architrave; and sometimes zinc flashing is used in very exposed positions, being turned up against the outside architrave. The small three-quarter round bead shown in the drawing may be omitted. The 3 by 4 stud is set so as to leave space for the weights. It is a good rule to remember that the distance from the stud to the glass opening is 5 inches, and the distance from the sill stud the same. The distance from stud at window head to glass opening is 4 inches

The pulley stile is of hard pine; and the parting strip, or stop-bead between the two sashes, is also hard pine. Between the outside architrave and the sash is put in a small screen strip, to give space enough for a mosquito screen between blinds and sash. On the inside of the sash is a stop-bead, which forms a part of the interior finish and covers the rough part of the window frame.

The upper part of the drawing shows a section through the window head. Sometimes the window frame head is made of thinner stock than that shown. This completes the rough window box as it is shipped from the sash factory to the building. At the building, it is nailed in place against the rough boarding; and later the sash, which come a little too large for their position, are fitted into place. Sections horizontally and vertically are shown through the sash, including meeting rail and muntins. The sash at the sill is wider than elsewhere, and underneath is usually beveled where it comes against the finished window stool, so that it will shut tight. There is also usually a groove underneath, to intercept any water that may blow in. The meeting-rail may be made on the outside sash, to drop below the meeting-rail on the inside sash, forming a drip which will prevent the water washing down on the glass of the lower sash.

The inside finish is frequently included on the general interior-finish drawings of the building, and is not always sent out with the window-frame details. The window stool is shown on the drawing, with a small space underneath where it comes against the sash, which forms a slight interruption for any water that may pass the other groove. The apron is nailed onto the sill and plaster stop; and a moulding is generally run under the window stool where it joins the apron. A back band may be laid around the inside architrave, against the plastering; or the inside architrave may be all one piece.

Fig. 46 shows several variations from the details of window frames illustrated in Fig. 45; and these can be still further varied if desired; or a combination of the parts may be made, taking certain details from each detail given.

The frames, unless otherwise shown, are usually made of white pine. Pulley stiles and parting beads are made of hard pine.

The pulley stiles are seven-eighths inch thick, tongued into the outside casings, as shown in the section through the side of the window box. The parting or stop beads are seven-eighths by one-half inch in

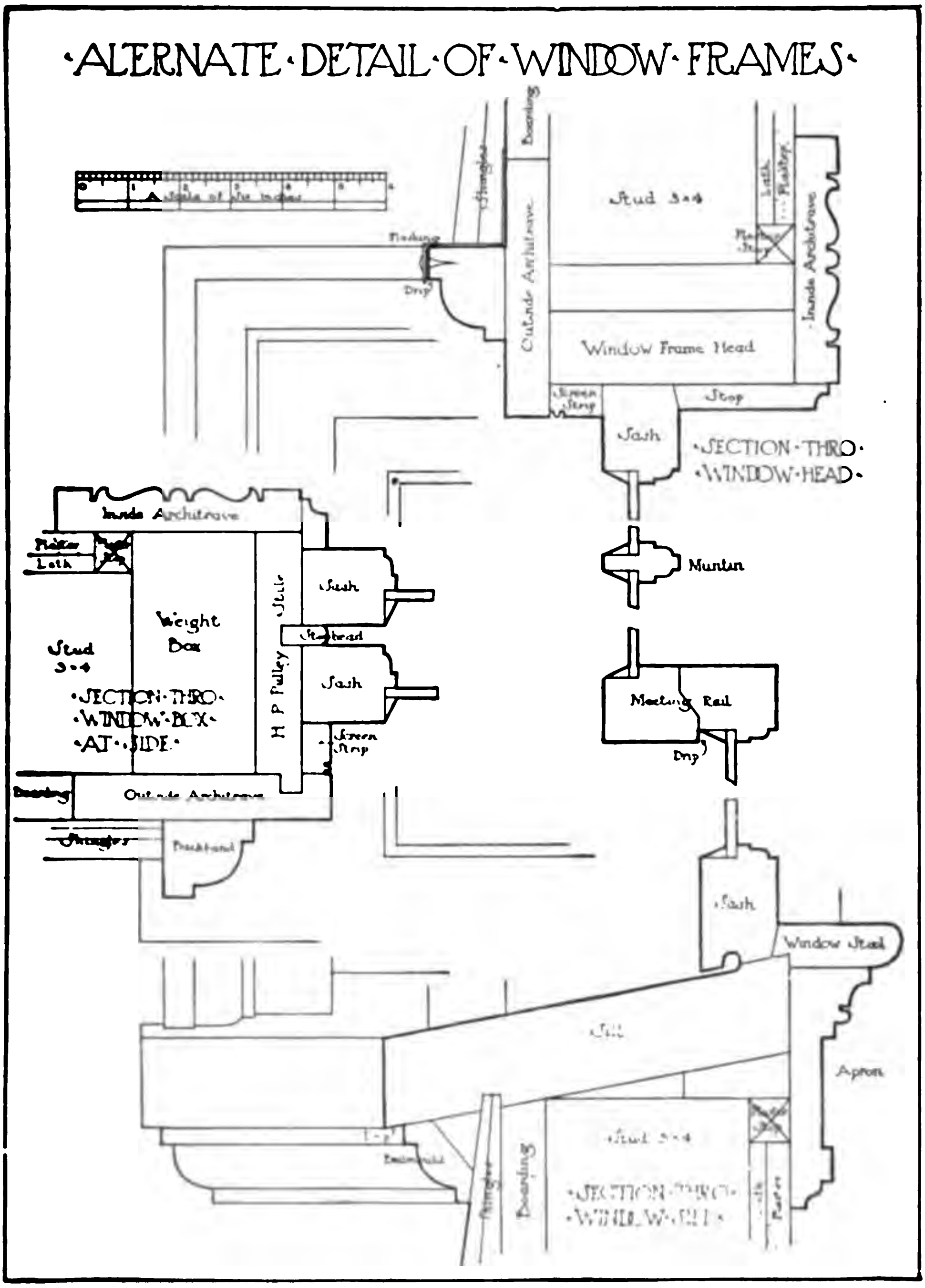

·ALTERNATE·DETAIL·OF·WINDOW·FRAMES·
Scale of Six Inches
0
1
2
3
4
5
6
Boarding
Shingles
Flashing
Drip
Outside Architrave
Stud 3×4
Lath
Plaster
Plaster Strip
Inside Architrave
Window Frame Head
Screen Strip
Stop
Sash
·SECTION·THRO·
·WINDOW·HEAD·
Muntin
Inside Architrave
Plaster
Lath
Stud 3×4
Weight Box
Stile
H P Pulley
Sash
Stopbead
Sash
Screen Strip
·SECTION·THRO·
·WINDOW·BOX·
·AT·SIDE·
Boarding
Outside Architrave
Shingles
Backband
Meeting Rail
Drip
Sash
Window Stool
Sill
Apron
Bedmould
Shingles
Boarding
Stud 3×4
·SECTION·THRO·
·WINDOW·SILL·
Plaster

Fig. 46.

size; sometimes they are made seven-eighths by three-eighths inch, the latter giving more room for the screen strip.

When two-coat work is specified for plaster, the plaster stops are generally three-quarters inch thick; when three-coat work is used, generally seven-eighths inch thick. Very often the window box is completed by ground-casing either three-quarters or seven-eighths inch thick, as shown in Fig. 47; in this case no ground or plaster stops are necessary around the window frames. The yoke or window-frame head is generally made one and three-eighths or one and one-half inches thick. The sills are set to pitch one and one-half inches. Care must be taken to see that the blinds are made sufficiently long to fit, as stock frames are frequently made with a slope of not over one-half inch in four inches. The outside casing—or outside architrave, as it is sometimes called—may be set either flush with the boarding or outside the boarding. When it is set flush with the boarding, the shingles may be carried directly across the joint, and finished against a back band, which comes around the outside of the window frame. The outside casing is generally seven-eighths inch thick, and five inches or sometimes four and one-half inches in width. In certain cases it is made of one and one-eighth inch stock, when it is to be set outside the boarding. Sometimes, instead of the back-band shown, an architrave made from one and one-eighth to one and three-quarter inch stock is planted on the outside casing. This would show the distinction between the outside casing and the outside architrave. The method of using a ground casing and outside casing flush with the boarding is inexpensive, and therefore in quite common use. It does not give sufficient room for a screen strip, and does not make a very tight casing where the pulley stile connects with the sill.

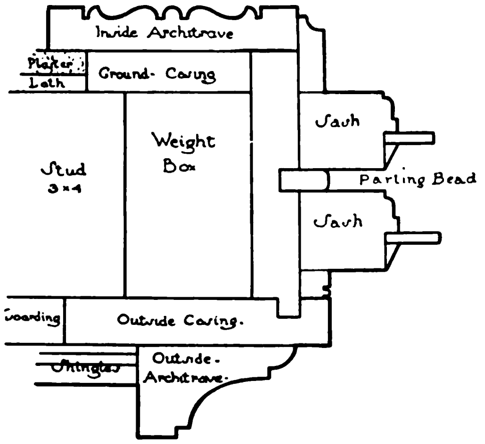
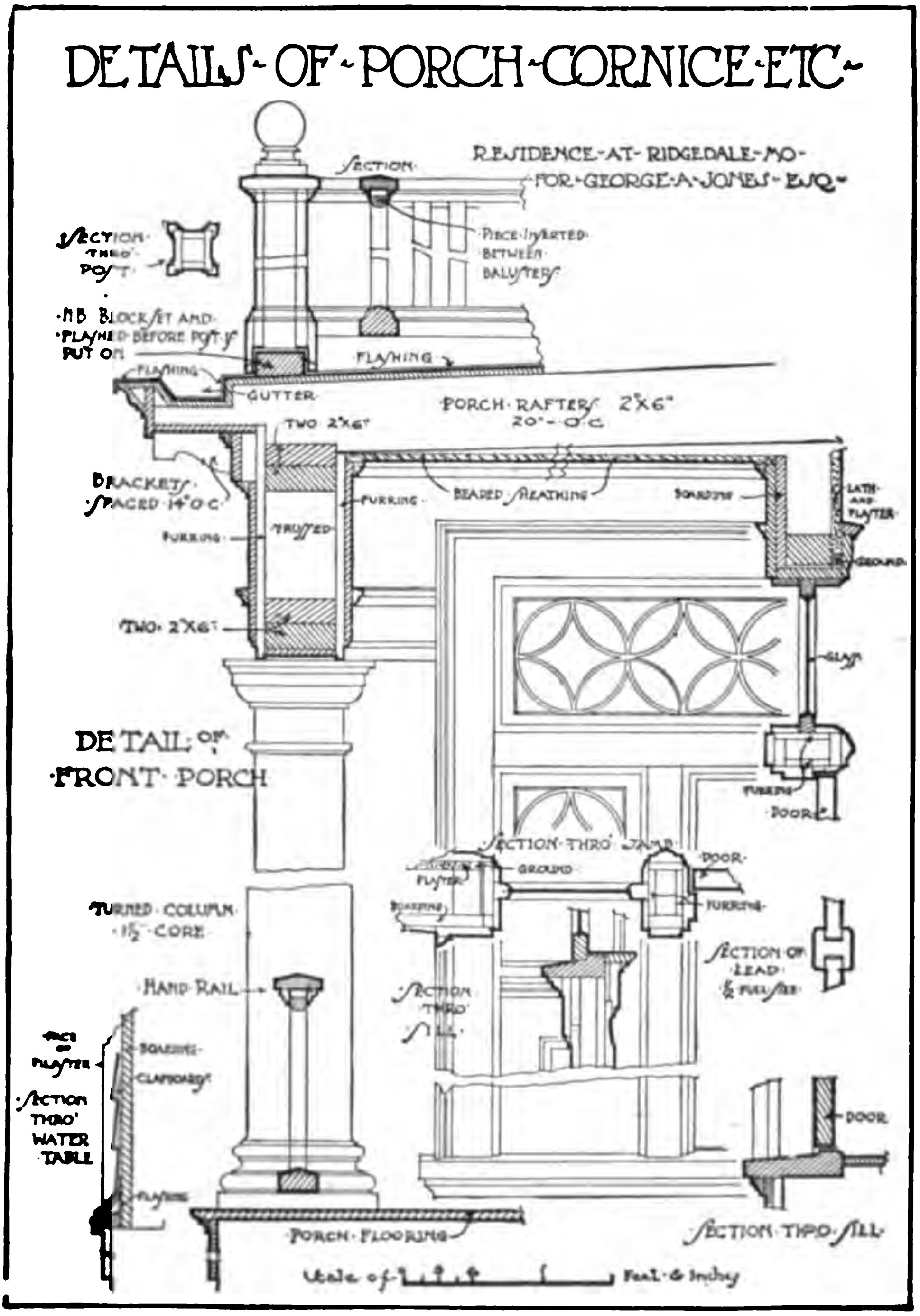


Fig. 47.


DETAILS OF PORCH CORNICE ETC
RESIDENCE AT RIDGEDALE MO
FOR GEORGE A JONES ESQ
SECTION
SECTION THRO' POST
PIECE INSERTED BETWEEN BALUSTERS
NB BLOCK SET AND FLASHED BEFORE POST IS PUT ON
FLASHING
FLASHING
GUTTER
PORCH RAFTERS 2"X6" 20" O C
TWO 2"X6"
BRACKETS SPACED 14" O C
FURRING
TRUSSED
FURRING
BEADED SHEATHING
BOARDING
LATH AND PLASTER
GROUND
TWO 2"X6"
GLASS
DETAIL OF FRONT PORCH
FURRING
DOOR
SECTION THRO' JAMB
PLASTER
GROUND
DOOR
BOARDING
FURRING
TURNED COLUMN 1½" CORE
SECTION OF LEAD ½ FULL SIZE
HAND RAIL
SECTION THRO' SILL
FACE OF PLASTER
BOARDING
CLAPBOARDS
SECTION THRO' WATER TABLE
FLASHING
DOOR
PORCH FLOORING
SECTION THRO SILL
Scale of Feet & Inches

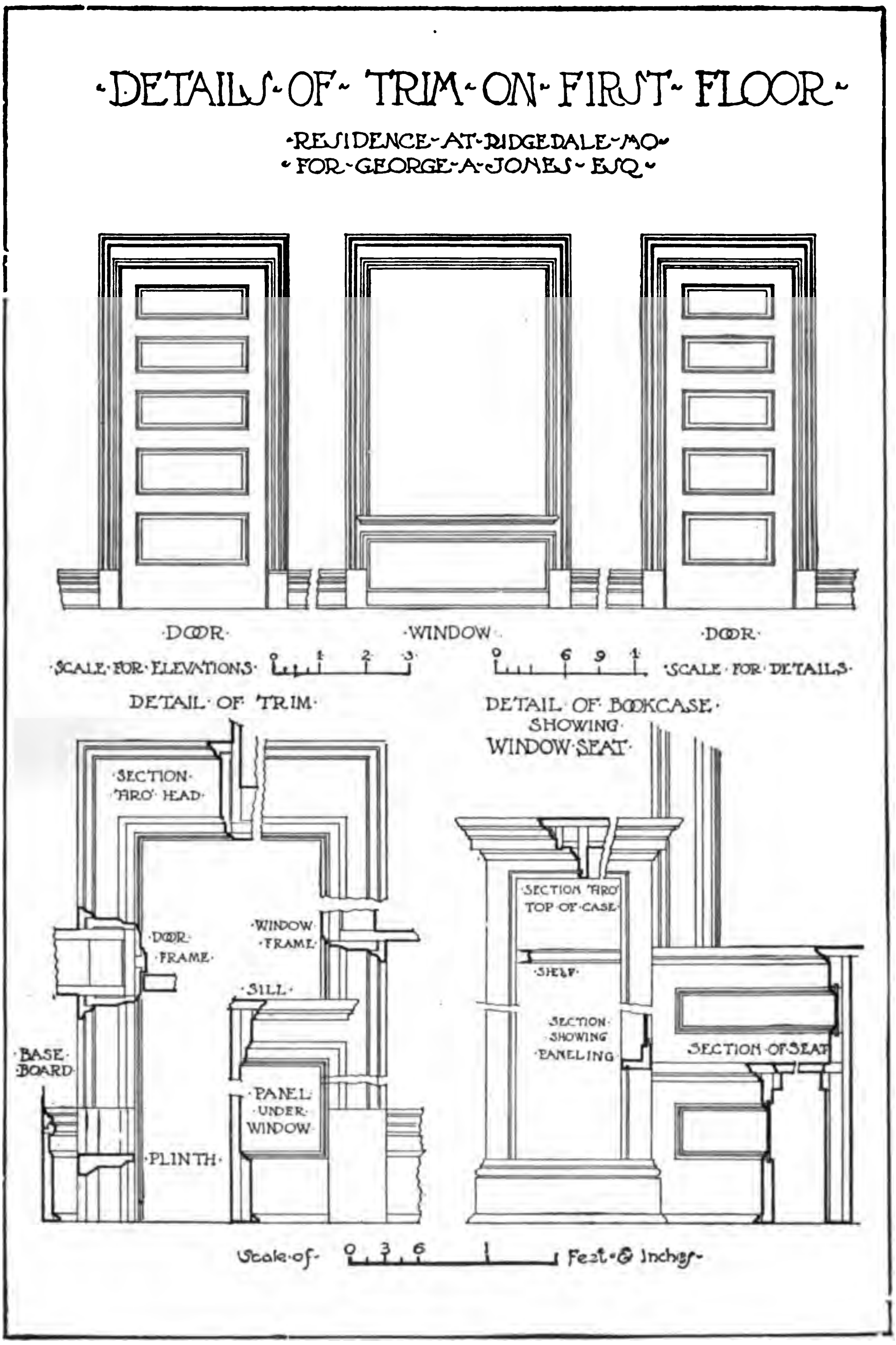

DETAILS OF TRIM ON FIRST FLOOR
RESIDENCE AT RIDGEDALE MO
FOR GEORGE A JONES ESQ
DOOR
WINDOW
DOOR
SCALE FOR ELEVATIONS 0 1 2 3
0 6 9 1 SCALE FOR DETAILS
DETAIL OF TRIM
DETAIL OF BOOKCASE SHOWING WINDOW SEAT
SECTION THRO' HEAD
DOOR FRAME
WINDOW FRAME
SILL
BASE BOARD
PANEL UNDER WINDOW
PLINTH
SECTION THRO' TOP OF CASE
SHELF
SECTION SHOWING PANELING
SECTION OF SEAT
Scale of 0 3 6 1 Feet & Inches

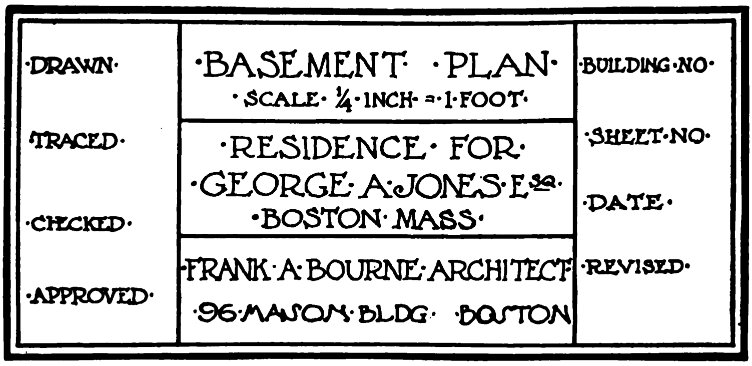
Fig. 49

The sash are usually made one and three-quarters inches thick, for house construction; sometimes, in less expensive work, they are made one and one-half inches thick, and, for cheap cellar windows, one and one-quarter inches thick. For plate glass they should not be less than one and three-quarter inches thick; and for important work, they are usually two and one-quarter inches thick. Frames may be veneered on the inside, to match the other interior finish.

Porch and Front Entrance. For detail of these, see Fig. 48.

Trim on First Floor. For detail, see Fig. 49.

Uniform Titles for Drawings. Fig. 50 shows a scheme for a uniform title to be use on working drawings. This may be made as a rubber stamp, the name of the drawing being lettered in, the name of the building being set up in rubber type, and the remainder being permanent. This stamp should be put on the drawing whenever it is started, a rubber dating stamp being used to give the date of beginning; the building number and sheet number should be recorded in the drawing book. The architect or draftsman who lays out the drawing puts his initials under the word "Drawn;" the draftsman who finishes it puts his initials under the word "Traced;" another puts his initials under the word "Checked," with the date; and finally the architect adds his initials and date after the drawings are ready to go out of the office. On the lower right-hand corner is a space where date of any revision may be entered. This stamp may be made four and seven-eighths inches long, so that it can be used on a 3 by 5 index card, for the drawing record; and also on a postal card, for a receipt to be signed by the con-



·DRAWN· ·TRACED· ·CHECKED· ·APPROVED·	·BASEMENT· ·PLAN· ·SCALE· ¼·INCH·=·1·FOOT· ·RESIDENCE· FOR· ·GEORGE·A·JONES·ESQ· ·BOSTON·MASS· ·FRANK·A·BOURNE·ARCHITECT ·96·MASON·BLDG· ·BOSTON	·BUILDING·NO· ·SHEET·NO· ·DATE· ·REVISED·

Fig. 50.

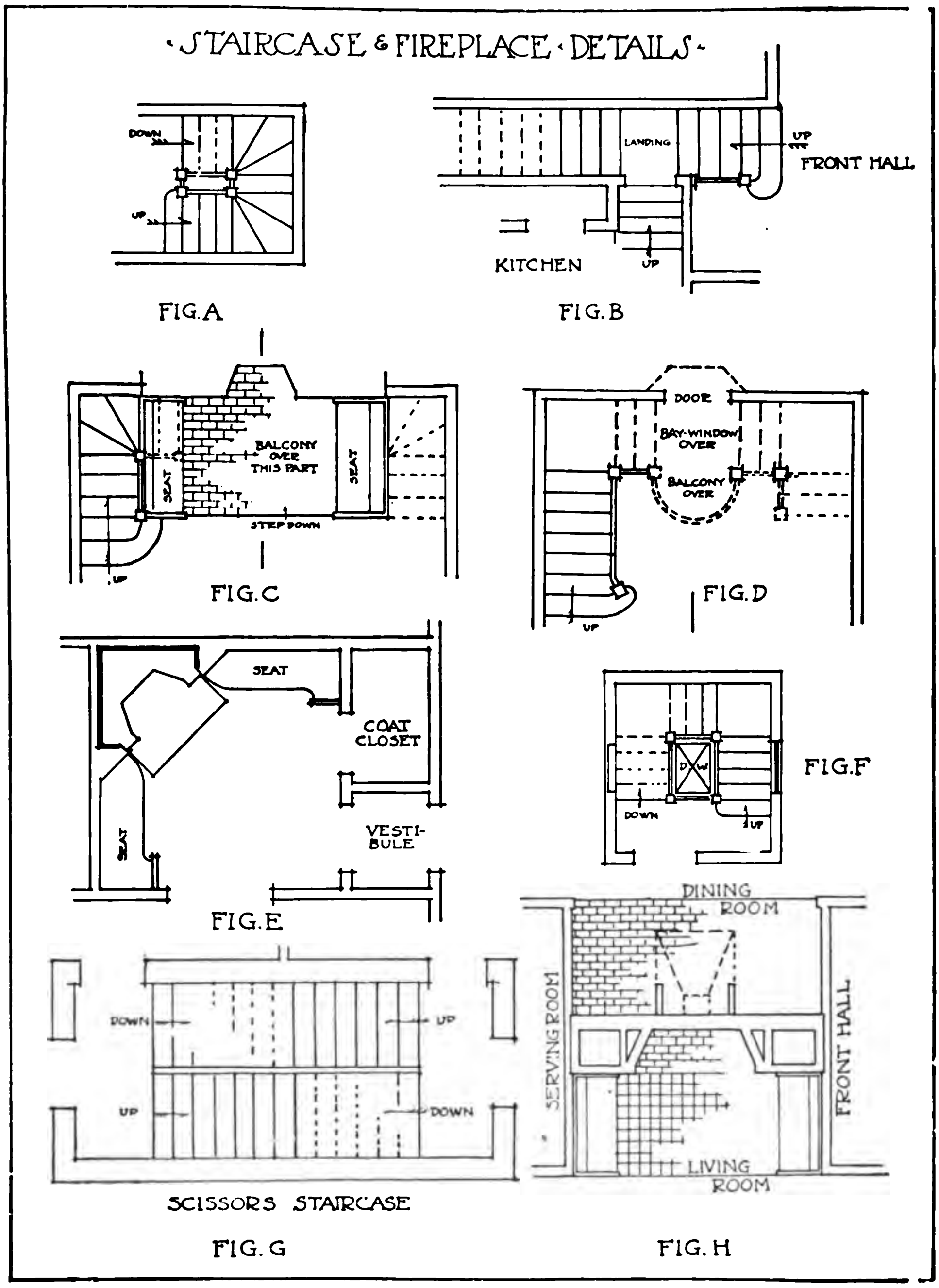
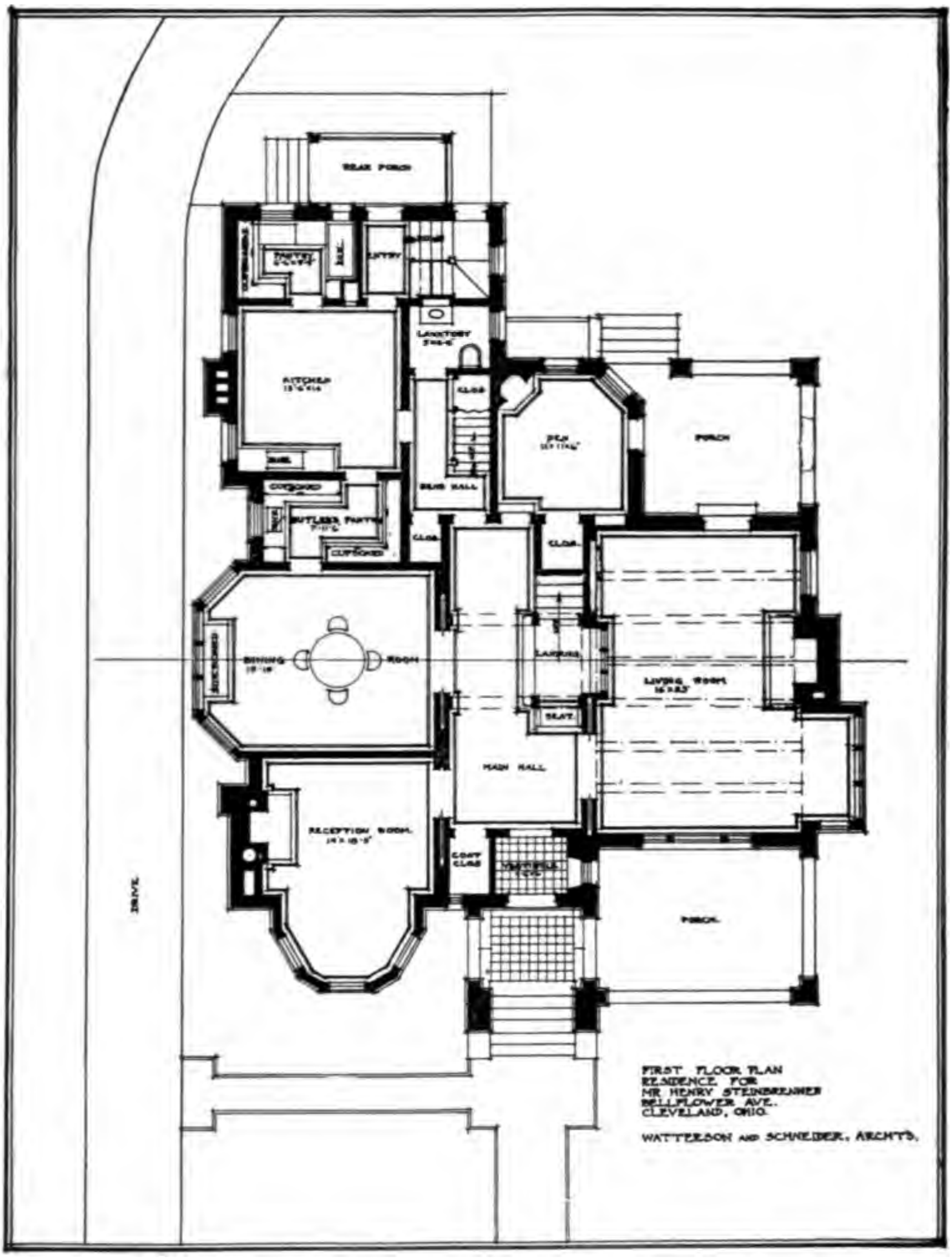
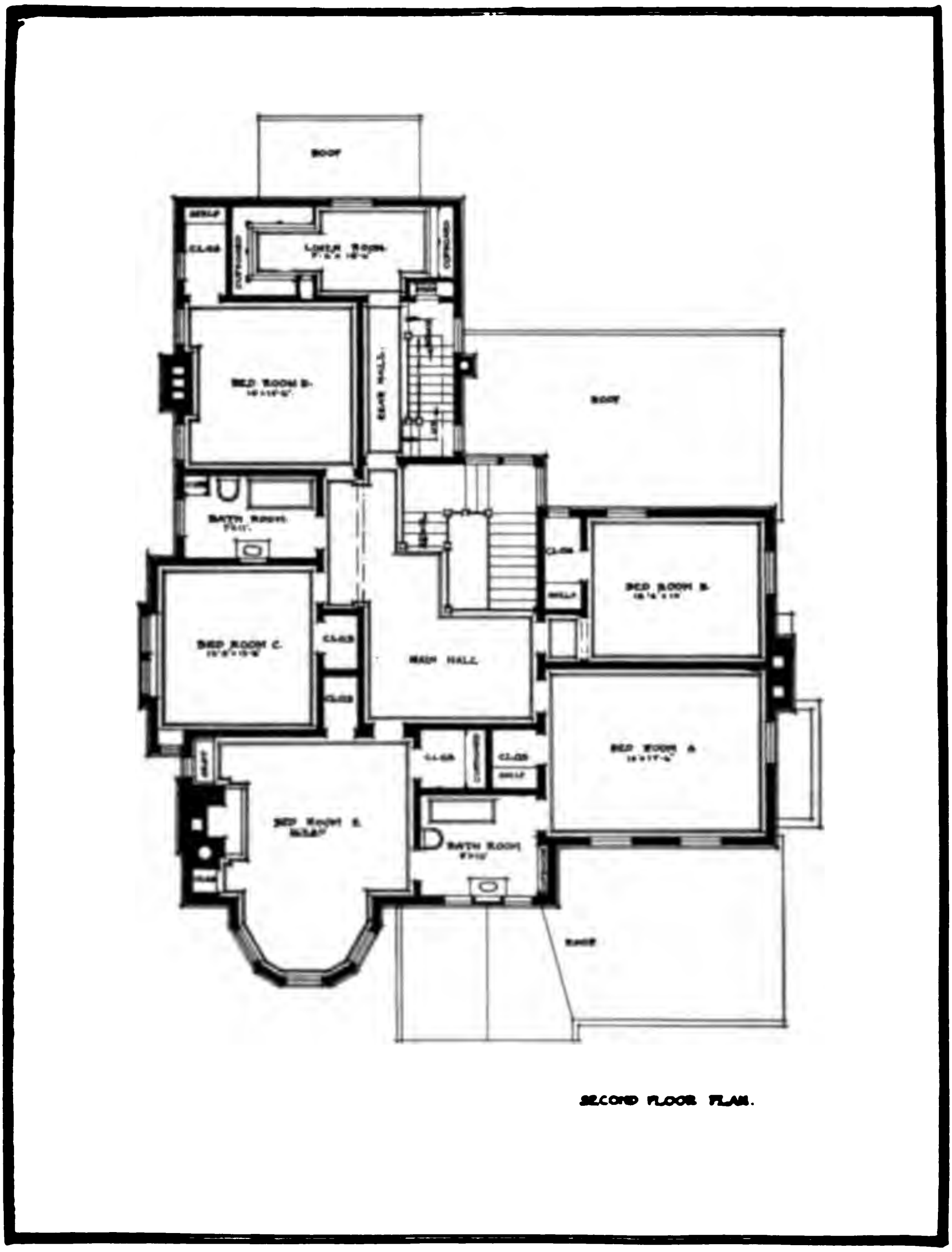

STAIRCASE & FIREPLACE DETAILS
DOWN
UP
FIG. A
LANDING
UP
FRONT HALL
KITCHEN
UP
FIG. B
BALCONY OVER THIS PART
SEAT
SEAT
STEP DOWN
UP
FIG. C
DOOR
BAY-WINDOW OVER
BALCONY OVER
UP
FIG. D
SEAT
COAT CLOSET
SEAT
VESTI-BULE
FIG. E
D
W
DOWN
UP
FIG. F
DOWN
UP
UP
DOWN
SCISSORS STAIRCASE
FIG. G
DINING ROOM
SERVING ROOM
FRONT HALL
LIVING ROOM
FIG. H

Fig. 51.



FIRST FLOOR PLAN OF HOUSE AT CLEVELAND, OHIO
Watterson and Schneider, Architects, Cleveland, Ohio
Cost of house $20,000. For second floor plan see opposite page
For exterior see page 91



HOUSE AT CLEVELAND, OHIO
Watterson & Schneider, Architects.
First-Floor Plan Shown on Opposite Page.

tractor on receiving the drawing, or for any other memoranda in regard to drawings.

Staircase and Fireplace Details. One of the best ways to prepare for the designing of buildings is to study and make memoranda of interesting plans and details. This is especially true in relation to house building, as well as to the planning of large buildings. Some of the most interesting sketch books are those filled with small-plan details which can be referred to and used in the same manner as window or door details could be used in designing elevations. Fig. 51 shows several such small drawings on one sheet.

Fig. A shows the usual way of working out a back staircase entirely enclosed between partitions, one staircase going down under the other. This is very compact, and may be worked out in wood or iron and between plaster or brick walls. The space may be larger or smaller than that shown. The width of stairs from the finished wall to center of rail should never be less than 2 feet 2 inches for the smallest staircase, and usually 2 feet 8 inches is employed for a back staircase. Sometimes the newel posts are brought together as one, making what is practically a circular staircase.

Fig. B shows a combination staircase; that is to say, the front staircase goes up to a landing, and then continues in any direction to the second floor. From this landing a door opens, leading down to the service part of the house, giving many of the advantages of a back staircase with loss of only a small amount of space.

Fig. C gives an interesting combination of staircase and fireplace. The fireplace is one step below the general floor level; and the ceiling is kept lower than the general ceiling of the room, with a small staircase leading up to a mezzanine story, above the fireplace, which may be arranged to look down on the main floor of the room or may form a sort of gallery.

Fig. D shows a staircase going up to a landing which is carried out into a room as a balcony indicated by dotted lines. At this level a little bay window is carried out over an outside doorway below. As there are only eleven risers shown, it would be necessary in this case to have the landing made of plank laid flat, to get head room for the seat.

Fig. E shows a compact arrangement of hall, coat closet, and out-

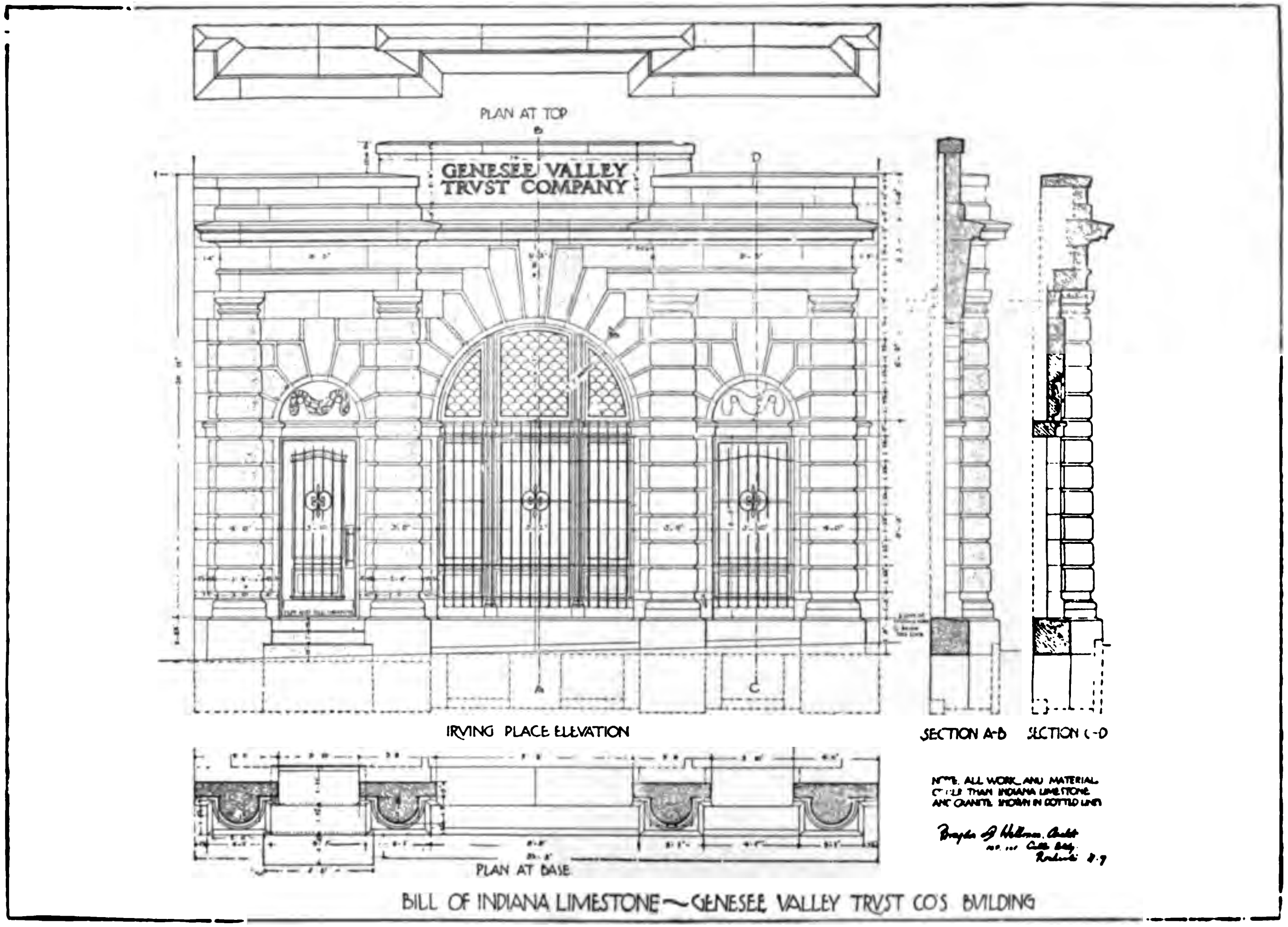
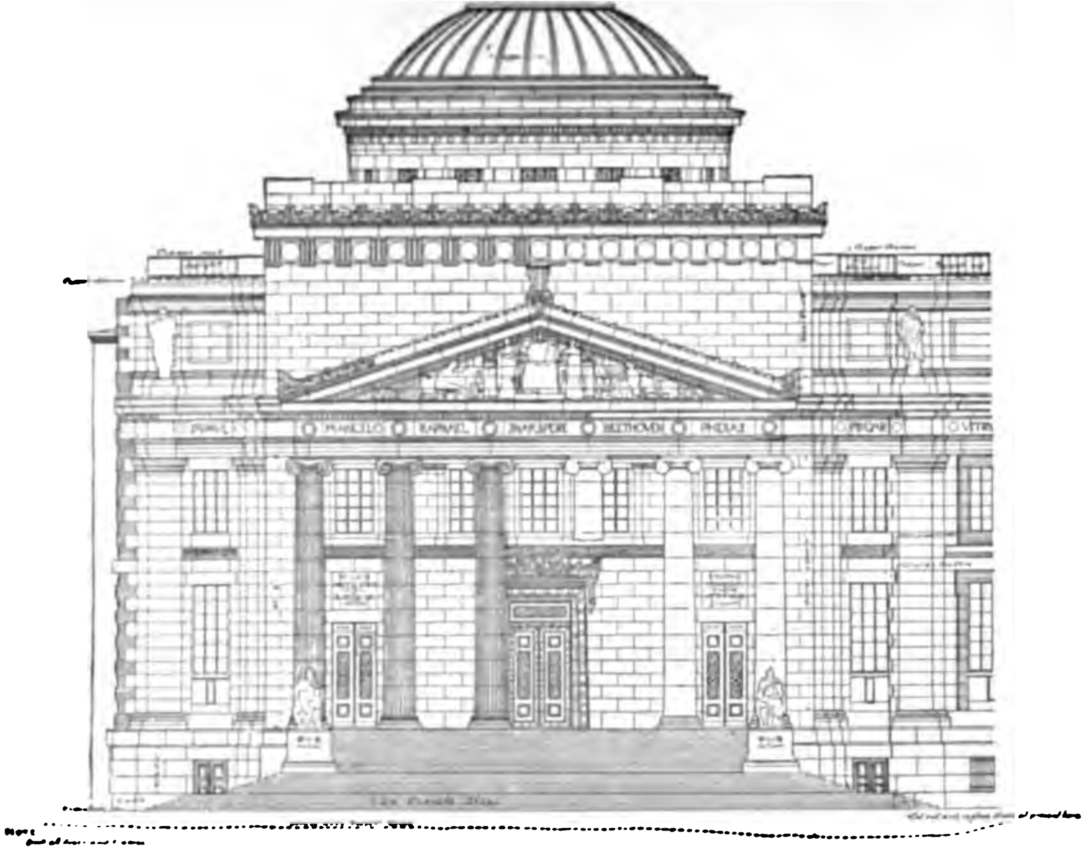

PLAN AT TOP
GENESEE VALLEY TRVST COMPANY
IRVING PLACE ELEVATION
SECTION A-B
SECTION C-D
PLAN AT BASE
NOTE. ALL WORK AND MATERIAL OTHER THAN INDIANA LIMESTONE AND GRANITE SHOWN IN DOTTED LINES
A
B
C
D
BILL OF INDIANA LIMESTONE—GENESEE VALLEY TRVST CO'S BVILDING

Fig. 52.



FRONT ELEVATION
CENTRAL PAVILION OF EASTERN PARKWAY FACADE
BROOKLYN INSTITVTE

Fig. 53.

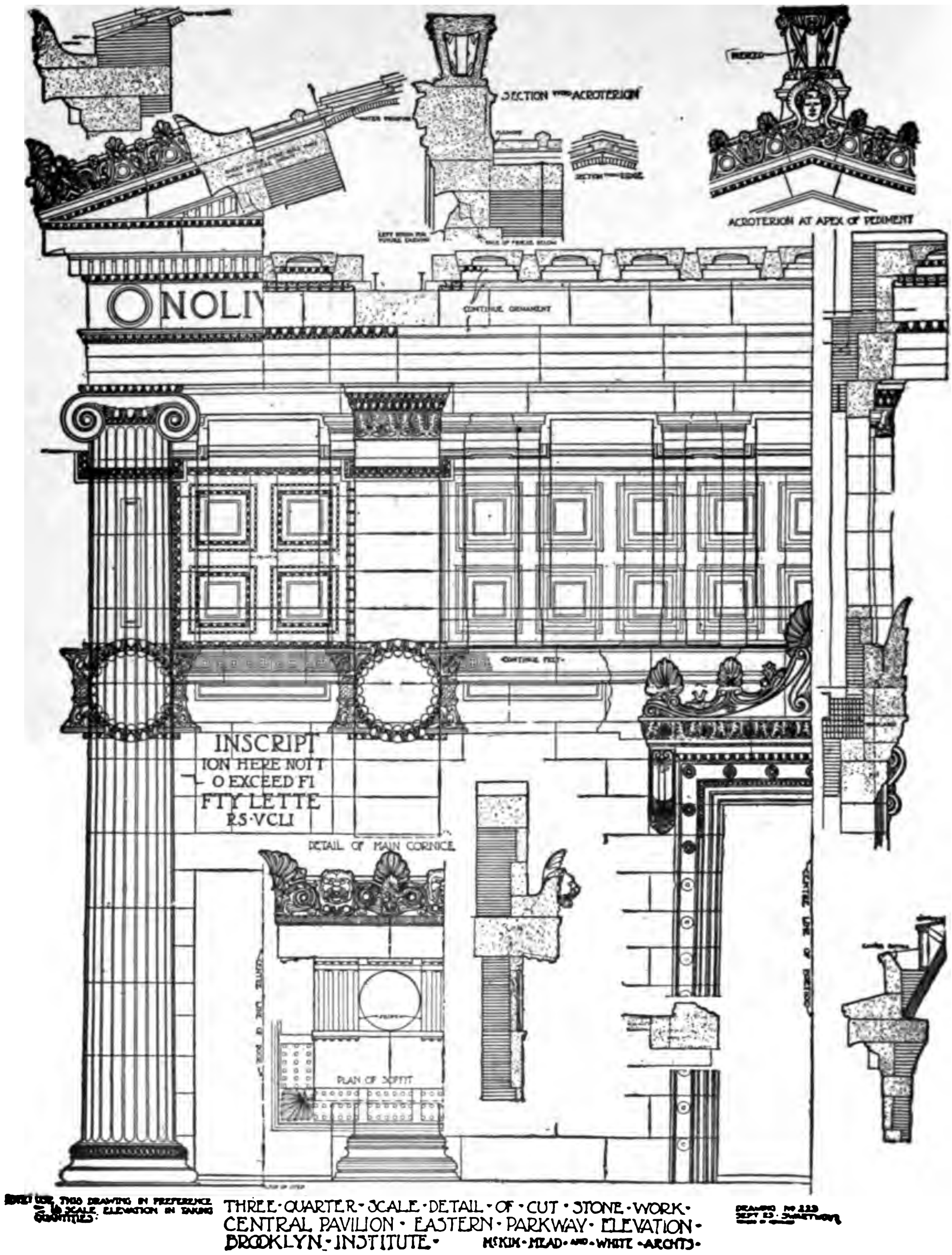

SECTION THRO ACROTERION
SECTION THRO EDGE
ACROTERION AT APEX OF PEDIMENT
NOLI
CONTINUE ORNAMENT
CONTINUE FRET
INSCRIPT
ION HERE NOT T
O EXCEED FI
FTY LETTE
RS·VCLI
DETAIL OF MAIN CORNICE
PLAN OF SOFFIT
THIS DRAWING IN PREFERENCE TO 1/8 SCALE ELEVATION IN TAKING QUANTITIES:
THREE·QUARTER·SCALE·DETAIL·OF·CUT·STONE·WORK·
CENTRAL PAVILION·EASTERN·PARKWAY·ELEVATION·
BROOKLYN·INSTITUTE·
McKIM·MEAD·AND·WHITE·ARCHTS·
DRAWING No 223
SEPT 23

Fig. 54.

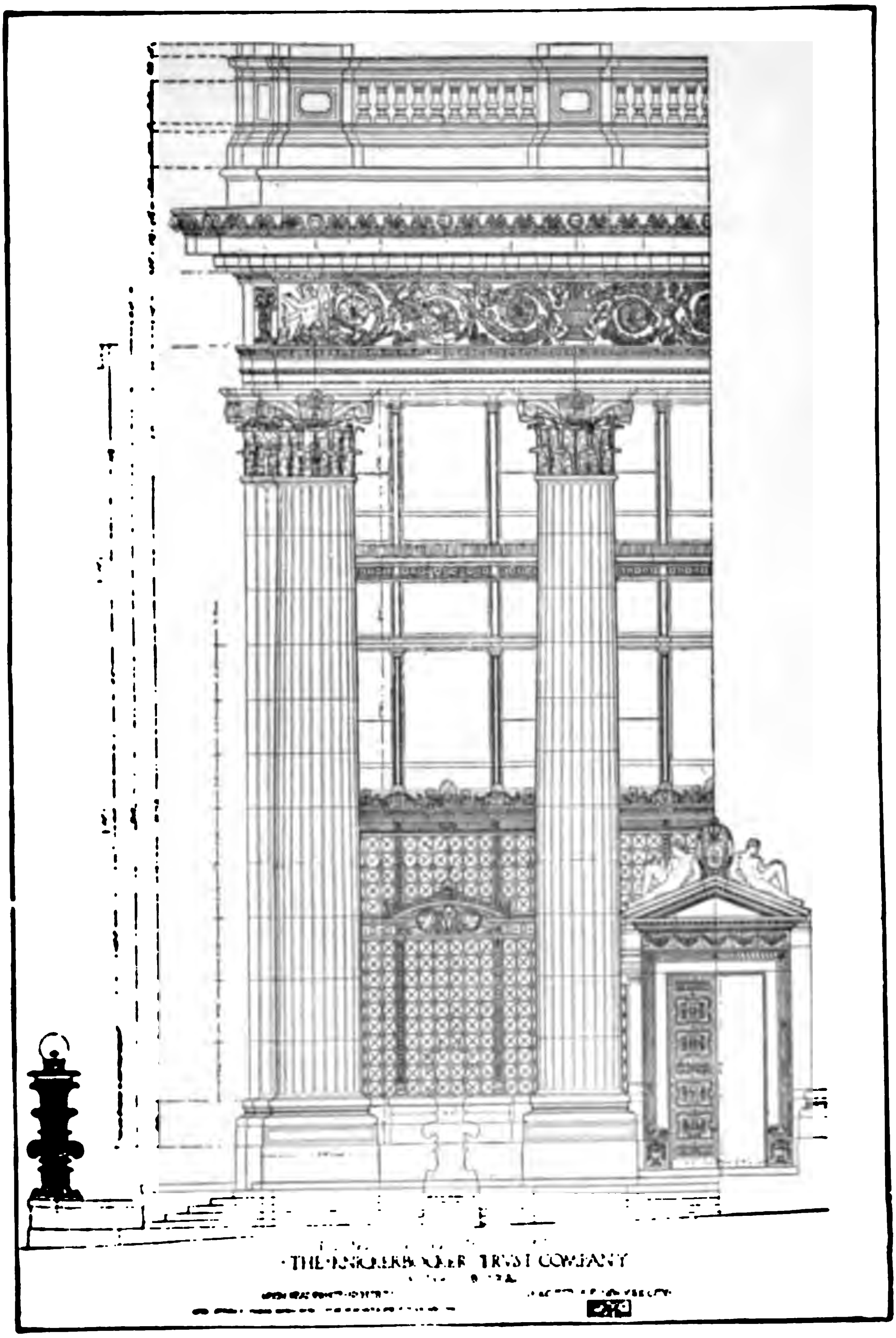


Fig. 55.

side vestibule, with an interesting arrangement of the ingle-nook and fireplace, and seats each side.

Fig. F shows another arrangement of circular staircase differing from that shown in Fig. A, as it contains space for a service elevator or lift.

Fig. G shows a scissors staircase, which is sometimes used in double houses occupied by different families on each floor. This construction makes a saving of space, as the staircases may be placed under each other, while each family is able to go from floor to floor by its own private staircase. This arrangement is also sometimes used in schoolhouses, where there is height enough to have mezzanine toilet rooms at the landings, with separate stairways for boys and girls in the same given space on plan.

Fig. H shows an arrangement for the fireplace between dining room and living room where space is desired for closets or serving room between. On one side is built the ordinary fireplace with seats on each side, the tiling being carried out to the end of the seats; on the other side the hearth is carried out with brick floor, and the hood is carried out over this so that a basket of coals can be set directly on the brick floor. Sometimes the fire-basket is placed below the floor level, so that the surface comes about on a level with the floor.

Figs. 52 to 55 show working drawings of prominent architectural firms. It should be noted how carefully and clearly everything is drawn—from the lettering to the sculptured parts.

The preliminaries to starting a drawing, are:

Stretch a half sheet of Whatman's cold-pressed paper on your drawing board. While this is drying, sketch out rapidly with pencil, T-square, and triangles, on a piece of manila detail paper, the main lines of the proposed drawing. This will show the proper placing of the drawing, and save much erasing on the final sheet.

Sometimes tracing paper may be mounted over the Whatman's paper, and a place cut for making the final drawing; or the study may be made directly on the tracing paper over the final sheet, and then cut out and redrawn or transferred.

The paper required for the first drawing is, therefore:

One sheet Whatman's "Imperial" drawing paper.

One yard manila detail paper.

Several yards of Rowney's English tracing paper.

ACKNOWLEDGMENT SHOULD BE MADE TO THE SEVERAL ARCHITECTS, DESIGNERS AND PUBLISHERS WHO HAVE ALLOWED THEIR DRAWINGS TO BE REPRODUCED IN THE SECTION ON ARCHITECTURAL LETTERING AND TO THE BATES & GUILD CO., OF BOSTON, FOR PERMISSION TO INCLUDE THE VARIOUS PLATES FROM "LETTERS AND LETTERING," A LARGER TREATISE BY FRANK CHOUTEAU BROWN.

Here
lies Interr'd
the Remains of
M^{rs} ELIZABETH FOSTE
Conſort of
M^{r} Eliſha FOSTER
e[illegible] who died *May* 28
1773 Aged 61.
Years.

RUBBING OF INCISED SLATE LETTERING FROM HEAD STONE IN KING'S CHAPEL BURYING GROUND, BOSTON, 1773.

ARCHITECTURAL LETTERING.

Architectural lettering may be divided into two general classes. The first is for titling and naming drawings, as well as for such notes and explanations as it is usual or necessary to put upon them; this may well be called "Office Lettering." The second includes the use of letters for architectural inscriptions to be carved in wood or stone, or cast in metal: for this quite a different character of letter is required, and one that is always to be considered in its relation to the material in which it is to be executed, and designed in regard to its adaptability to its method of execution. This may be arbitrarily termed "Inscription Lettering," and as a more subtle and less exact subject than office lettering it may better be taken up last.

OFFICE LETTERING.

Architectural office lettering has nothing in common with the usual Engineering letter, or rather, to be more exact, the reverse is true: Engineering lettering has nothing in common with anything else. Its terminology is wrong and needlessly confusing inasmuch as it clashes with well and widely accepted definitions. Therefore it will be necessary to start entirely anew, and if the student has already studied any engineering book on the subject, to warn him that in this instruction paper such terms as Gothic, etc., will be used in their well understood Architectural meaning and must not be misinterpreted to include the style of letter arbitrarily so called by Engineers.

The first purpose of the lettering on an architectural plan or elevation is to identify the sheet with its name and general descriptive title, and further, to give the names of the owner and architect. The lettering for this purpose should always be rather important and large in size, and its location, weight and height must be exactly determined by the size, shape and weight of the plan or elevation itself, as well as its location upon and relation to the paper on which it is drawn, in order to give a pleasing effect and to best finish or set off the drawing itself. The style of letter used may be suggested, or even demanded, by the design of the building represented. Thus Gothic lettering might be appropriate on a drawing of a Gothic church, just as Italian Renaissance lettering would be for a building of that style, or as Classic lettering would seem most suitable on the drawings for a purely Classic design; while each letter or legend would look equally out of place on any one of the other drawings.

LETTER FORMS.

It may be said that practically all the lettering now used in architectural offices in this country is derived, however remotely it may seem in some cases, from the old Roman capitals as developed and defined during the period of the Italian Renaissance. These Renaissance forms may be best studied first at a large size in order to appreciate properly the beauty and the subtlety of their individual proportions. For this purpose it is well to draw out at rather a large scale, about four or four and one-half inches in height, a set of these letters of some recognized standard form, and in order to insure an approximately correct result some such method of construction as that shown in Figs. 1 and 2 should be followed. This alphabet, a product of the Renaissance, though of German origin, is one adapted from the well-known letters devised by Albrecht Dürer about 1525, and is here merely redrawn to a simpler constructive method and arranged in a more condensed fashion. This may be accepted as a good general form of Roman capital letter in outline, although it lacks a little of the Italian delicacy of feeling and thus betrays its German origin.

The letter is here shown in a complete alphabet, including those letters usually omitted from the Classic or Italian inscriptions: the J, U (the V in its modern form) and two alternative W's, which are separately drawn out in Fig. 1.

These three do not properly form part of the Classic alphabet and have come into use only within comparatively modern times. For this reason in any strictly Classic inscription the letter I should be used in place of the J, and the V in place of the U. It is sometimes necessary to use the W in our modern spelling, when the one composed of the double V should always be employed.

The system of construction shown in this alphabet is not exactly the one that Dürer himself devised. The main forms of the letters as well as their proportions are very closely copied from the original alphabet, but the construction has been somewhat simplified and some few minor changes made in the letters themselves, tending more towards a modern and more uniform character. The two W's, one showing the construction with the use of the two overlapping letter V's, and one showing the W incorporated upon the same square unit which carries the other letters (the latter form being the one used by Dürer himself), are shown separately in Fig. 1. It should be noticed that every letter in the alphabet, except one or two that of necessity lack the requisite width (such as the I and J) is based upon and fills up the outline of a square, or in the case of the round letters, a circle which is itself contained within the square. This alphabet should be compared with the alphabet in Fig. 4, attributed to Sebastian Serlio, an Italian architect of the sixteenth century. By means of this comparison a very good idea may be obtained of the differences and characteristics which distinguish the Italian and German traits in practically contemporaneous lettering.

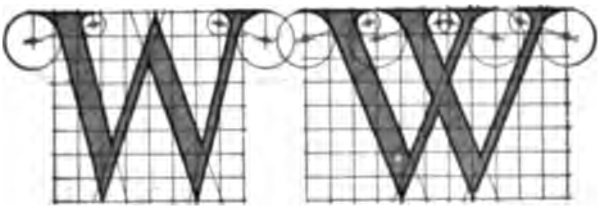


Fig. 1 Two Alternative Forms of the Letter W, to Accompany the Alphabet Shown in Fig. 2

After once drawing out these letters at a large size, the beginner may find that he has unconsciously acquired a better constructive feeling for the general proportions of the *individual* letters and should thereafter form the letters free-hand without the aid of any such scheme of construction, merely referring occasionally to the large chart as a sort of guide or check upon the eye. For this purpose it should be placed conveniently, so that it may be referred to when in doubt as to the outline of any individual letter. By following this course and practicing thor-

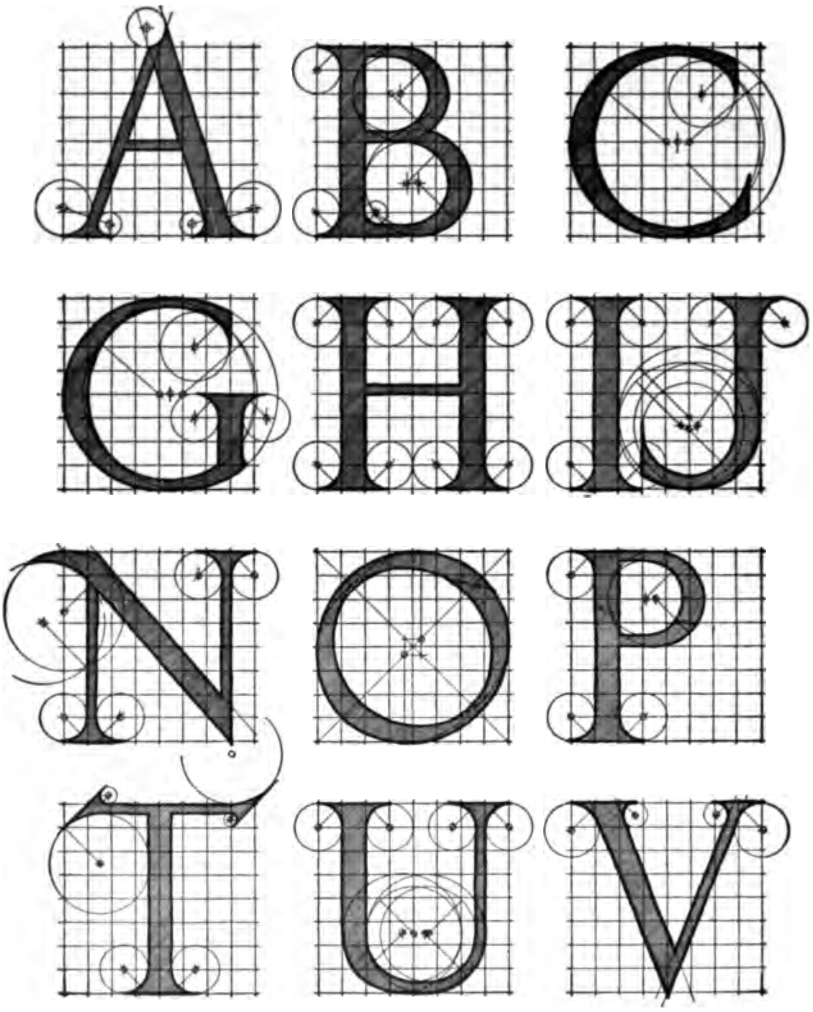


Fig. 2. Alphabet of Classic Renaissance Letters According to Albrecht Dürer
(see opposite page)
Adapted and Reconstructed by Frank Chouteau Brown, Boston, Massachusetts

oughly the use of the letters in word combinations, a ready command over this important style of letter will eventually be acquired.

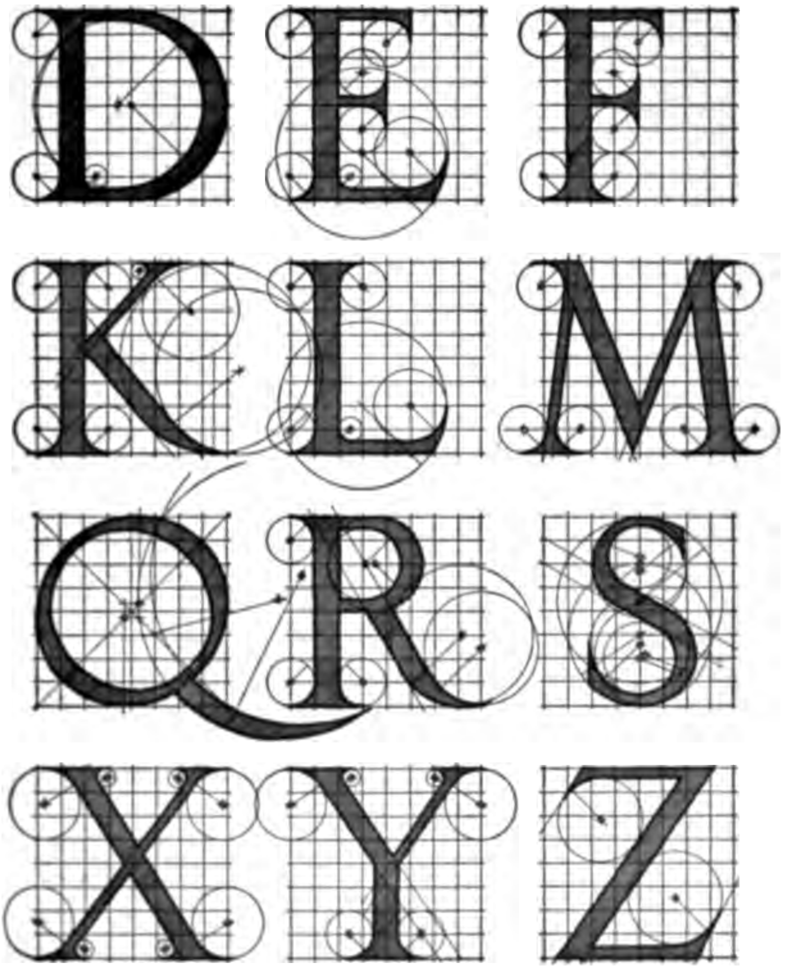


Fig. 2. Alphabet of Classic Renaissance Letters According to Albrecht Dürer (see opposite page)

Adapted and Reconstructed by Frank Chouteau Brown, Boston, Massachusetts

In practice it will soon be discovered that a letter in outline and of a small size is more difficult to draw than one solidly blacked-in, because the defining outline must be even upon both its edges; and that as the eye follows more the inner side of this line than it does the outer, both in drawing and afterwards in recognizing the letter form, the inaccuracies of the outer side of the line are likely to show up against the neighboring letters, and produce an irregularity of effect that it is difficult to overcome, especially for the beginner; while in a solidly blacked-in letter, it is the outline and proportions alone with which the draftsman must concern himself. Therefore, a letter in the same style is more easily and rapidly drawn when solidly blacked-in than as an "open" or outline letter. In many cases where it is desired to give a more or less formal and still sketchy effect, a letter of the same construction but with certain differences in its characteristics may be used. It should not be so difficult to draw, and much of the same character may still be retained in a form that is much easier to execute. Some such letter as is shown at the top of Fig. 10, or any other personal variation of a similar form such as may be better adapted to the pen of the individual draftsman would answer this purpose. The titles shown in Figs. 3 and 5 include letters of this same general type, but of essentially different character.

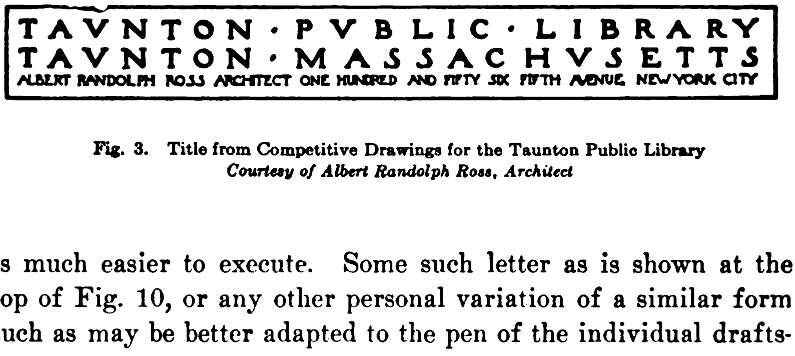

TAVNTON · PVBLIC · LIBRARY
TAVNTON · MASSACHVSETTS
ALBERT RANDOLPH ROSS ARCHITECT ONE HUNDRED AND FIFTY SIX FIFTH AVENUE NEW YORK CITY

Fig. 3. Title from Competitive Drawings for the Taunton Public Library
Courtesy of Albert Randolph Ross, Architect

In drawing a letter that is to be incised in stone it is customary to show in addition to the outline, a third line about in the center of the space between the outside lines. This additional line represents the internal angle that occurs at the meeting of the two sloping faces used to define the letter. An example is shown in Figs. 24 and 25, while in Fig. 7, taken from drawings for a building by McKim, Mead & White, the same convention is frankly employed to emphasize the principal lettering of a pen-drawn title.

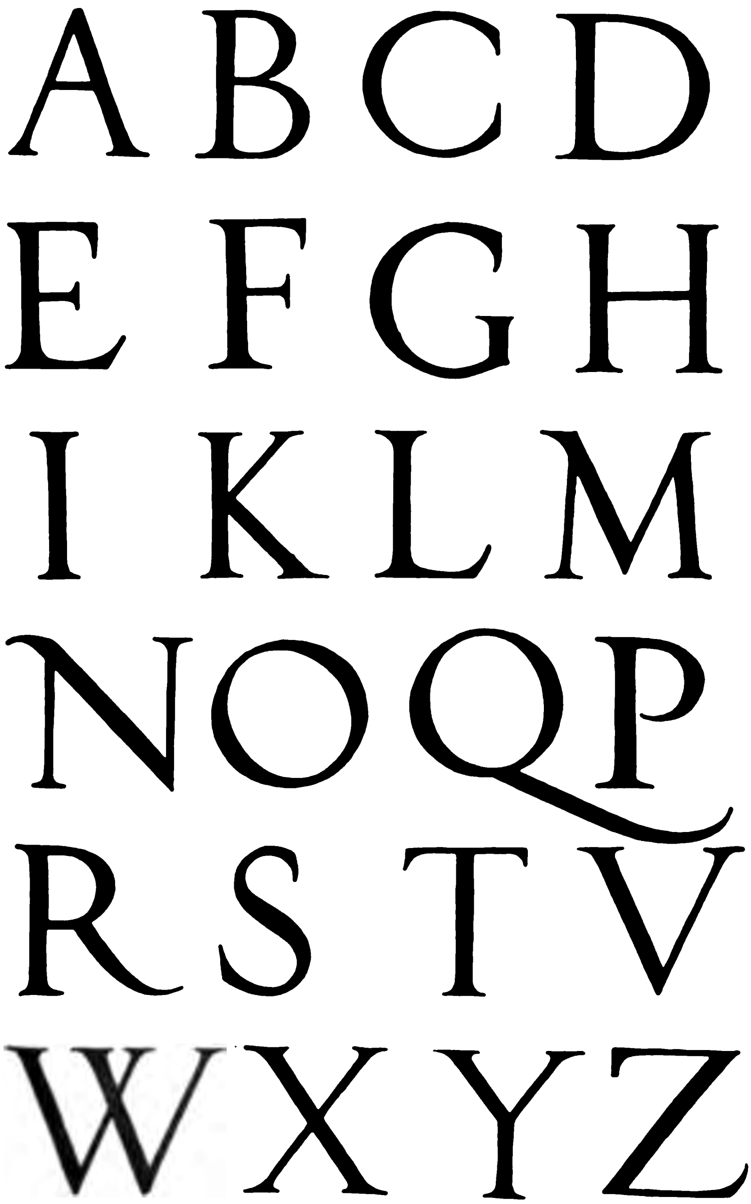
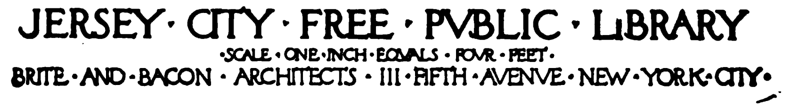


Fig. 4 Italian Renaissance Alphabet, According to Sebastian S

For the purpose of devising a letter that may be drawn with one stroke of the pen and at the same time retain the general character of the larger, more Classic alphabet, in order that it may be consistently used for less important lettering on the same drawing, it is interesting to try the experiment of making a skeleton of the letters in Figs. 1 and 2. This consists in running a single heavy line around in the middle of the strokes that form the outline of these letters. This "skeleton" letter, with a few modifications, will be found to make the best possible capital letter for rapid use on working drawings, etc., and in a larger size it may be used to advantage for titling details (Fig. 9). It will also prove to be singularly effective for principal lettering on plans, to give names of rooms, etc. (Fig. 13), while in a still smaller size it may sometimes be used for notes, although a minuscule or lower case letter will be found more generally useful for this purpose.



JERSEY · CITY · FREE · PVBLIC · LIBRARY
·SCALE · ONE · INCH · EQVALS · FOVR · FEET·
BRITE · AND · BACON · ARCHITECTS · III · FIFTH · AVENVE · NEW · YORK · CITY ·

Fig. 5. Title from Drawings for the Jersey City Public Library
Courtesy of Brite & Bacon, Architects

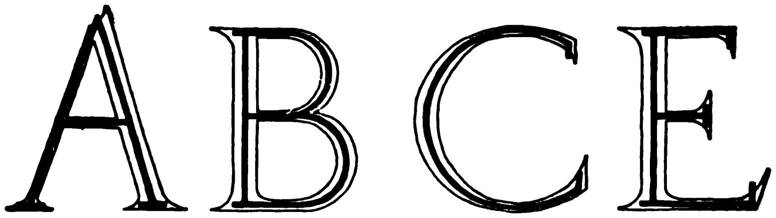


Fig. Fig. 6. "Skeleton" Construction of Letters Shown in Fig. 2 Fig. 2.

In Fig. 6 are shown four letters where the skeleton has been drawn within the outline of the more Classic form. It is un-

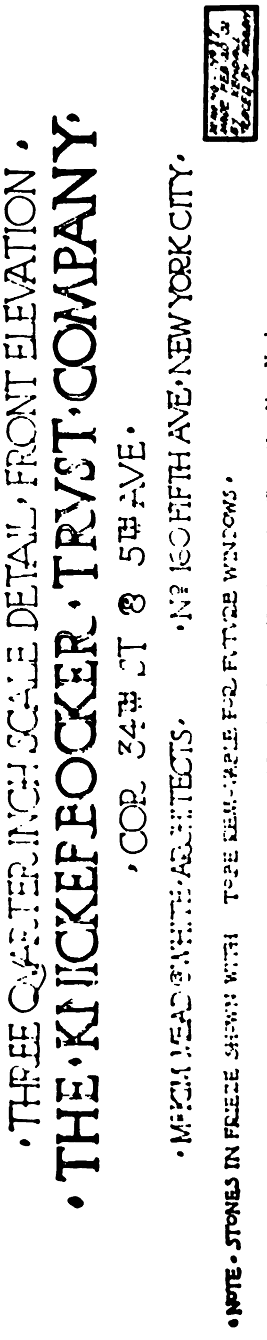

·THREE QUARTER INCH SCALE DETAIL, FRONT ELEVATION·
·THE·KNICKERBOCKER·TRUST·COMPANY·
·COR 34TH ST & 5TH AVE·
·McKIM, MEAD & WHITE, ARCHITECTS· ·No 160 FIFTH AVE, NEW YORK CITY·
·NOTE·STONES IN FRIEZE SHOWN WITH
FOR FUTURE WINDOWS·

Fig. 7. Title from Drawing of Building for the Knickerbocker Trust Co., New York
Courtesy of McKim, Mead & White [illegible]

necessary to continue this experiment at a greater length, as it is believed the idea is sufficiently developed in these four letters. In addition it is merely the theoretical part of the experiment that it is desirable to impress upon the draftsman. In practice it will be found advisable to make certain further variations from this "skeleton" in order to obtain the most pleasing effect possible with a single-line letter. But the basic relationship of these two forms will amply indicate the propriety of using them in combination or upon the same drawing.

It will be found that the letter more fully shown in Fig. 10 is almost the same as the letter produced by this "skeleton" method, except that it is more condensed. That is, the letters are narrower for their height and a little freer or easier in treatment. This means that they can be lettered more rapidly and occupy less space, and also that they will produce a more felicitous effect.

In actual practice, the free capitals shown in Fig. 10 will be found to be of the shape that can be made most rapidly and easily, and this style or some similar letter should be studied and practiced very carefully.

Other examples of similar one-line capitals will be found used with classic outline or blacked-in capitals on drawings, Figs. 3, 5 and 7.

In Figs. 8, 9 and 13 these one-line letters are used for principal titles as well, and with good effect.

In Fig. 10 is shown a complete alphabet of this single-line letter, and the adaptability of this character for use on details is indicated by the title taken from one and reproduced in Fig. 9. In the same plate, Fig. 10, is also shown an excellent form of small letter that may be used with any of these capitals. It is quite as plain as any Engineer's letter, and is easier to make, and at the same time when correctly placed upon the drawing it is much more decorative. This entire plate is reproduced at a slight reduction from the size at which it was drawn, so that it may be studied and followed closely.

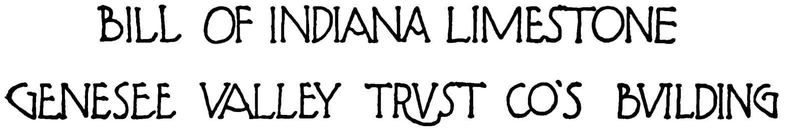

BILL OF INDIANA LIMESTONE
GENESEE VALLEY TRUST CO'S BUILDING

Fig. 8. Title from an Architectural Drawing
Courtesy of Claude Fayette Bragdon, Architect, Rochester, New York

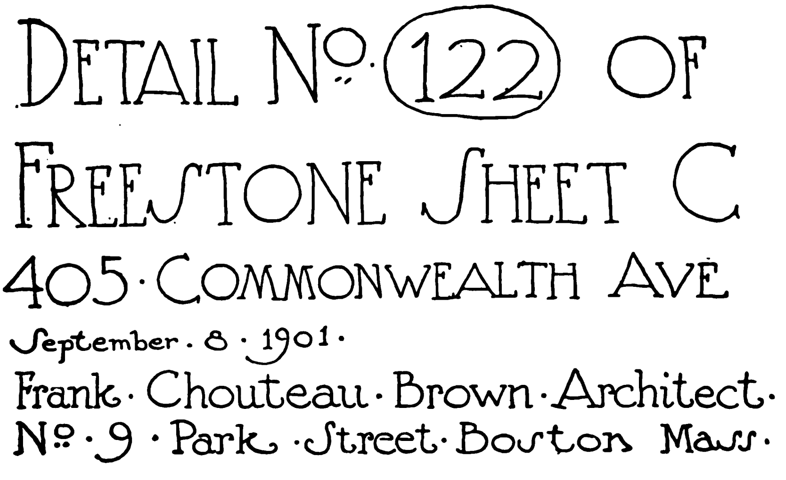
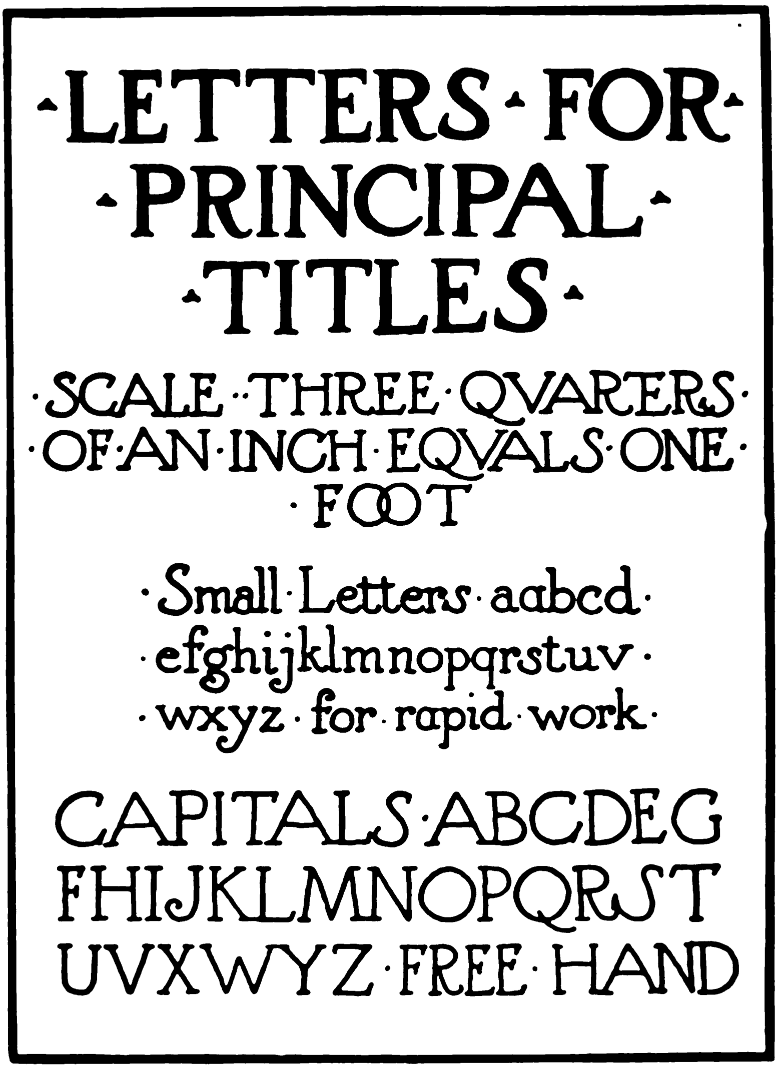


Fig. 9. Title from Detail



·LETTERS·FOR·
·PRINCIPAL·
·TITLES·
·SCALE··THREE·QVARTERS·
·OF·AN·INCH·EQVALS·ONE·
·FOOT

·Small·Letters·aabcd·
·efghijklmnopqrstuv·
·wxyz·for·rapid·work·

CAPITALS·ABCDEG
FHIJKLMNOPQRST
UVXWYZ·FREE·HAND

Fig. [illegible]. Letters for Architectural Office Use

Fig. 10 should be most carefully studied and copied, as it represents such actual letter shapes as are used continually on architectural drawings, and such as would, therefore, be of the most use to the draftsman. He should so perfect himself in these alphabets that he will have them always at hand for instant use.

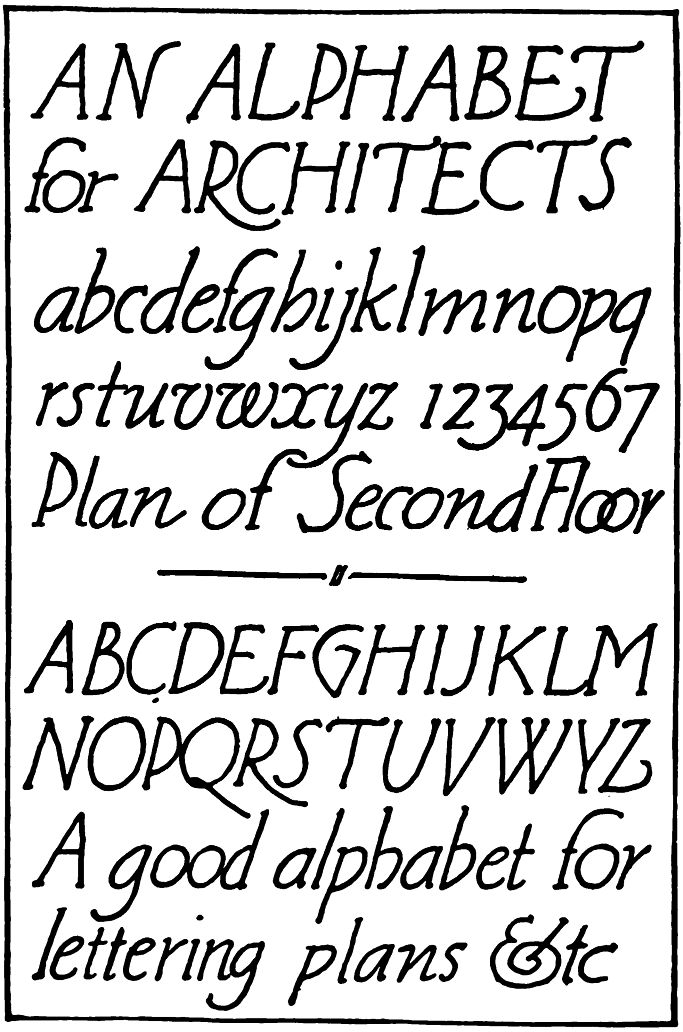


Fig. 11. Panel Showing Single-Line Italic Letters
Courtesy of Claude Fayette Bragdon, Architect, Rochester, New York

The alphabets of capital and minuscule one-line letters shown in Fig. 11 are similar in general type to those we have just been discussing, except that they are sloped or inclined letters and therefore come under the heading of "Italics." The Italic letter is ordinarily used to emphasize a word or phrase in a sentence where the major portion of the letters are upright; but where the entire legend is lettered in Italics this effect of emphasis is not noticeable, and a pleasing and somewhat more unusual drawing is likely to result. If it is deemed advisable to emphasize any portion of the lettering on such a drawing, it is necessary only to revert to the upright form of letter for that portion.

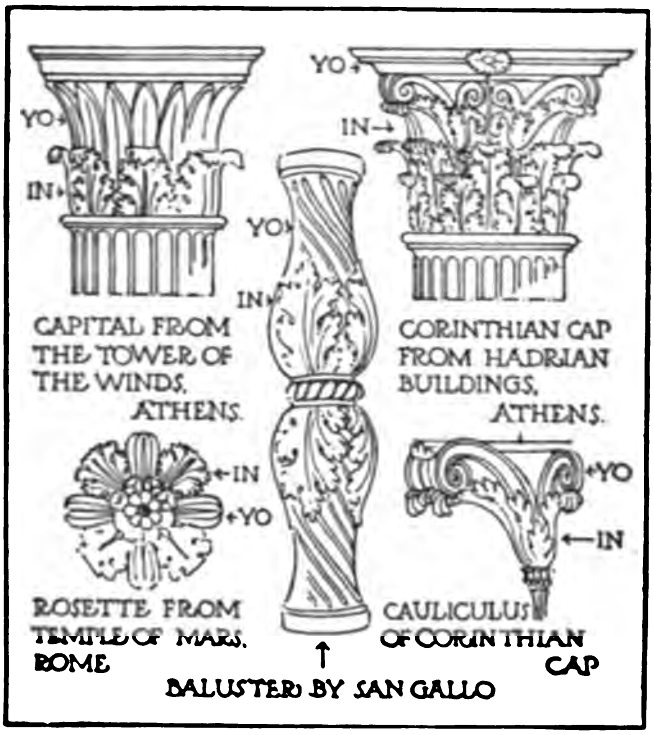

YO
IN
CAPITAL FROM THE TOWER OF THE WINDS, ATHENS
YO
IN
YO
IN
CORINTHIAN CAP FROM HADRIAN BUILDINGS, ATHENS
IN
YO
ROSETTE FROM TEMPLE OF MARS, ROME
YO
IN
CAULICULUS OF CORINTHIAN CAP
BALUSTER BY SAN GALLO

Fig. 12. Excellent Example of Skeleton Single-Line Lettering
Courtesy of Claude Fayette Bragdon, Architect, Rochester, New York

The single-line capitals and small letters on the usual architectural plan or working drawing are illustrated in Fig. 13, where such a plan is reproduced. This drawing was not one made specially to show this point, but was selected from among several as best illustrating the use of the letter forms themselves, as well as good placing and composition of the titles, both in regard to the general outline of the plan and their spacing and location in the various rooms. It is apparent that it is not exactly accurate in the centering in one or two places. For instance, in the general title, the two lower lines are run too far to the right of the center line, and this should be corrected in any practice work where these principles will be utilized. It may be well to say that the actual length of this plan in the original drawing was thirteen inches, and the rest of it large in proportion. The student should not attempt to redraw any such example as this at the size of the illustration. He must always allow for the reduction from the original drawing, and endeavor to reconstruct the example at the original size, so that it would have the same effect when reduced as the model that he follows.

The letters for notes and more detailed information should be much simpler and smaller than and yet may be made to accord with the larger characters. Such a rapid letter as that shown in Fig. 10, for instance, may be used effectively with a severely classical title. Of course, no one with a due regard for propriety or for economy of time would think of using the Gothic small letter for this purpose.

The portion of a drawing shown in Fig. 14 illustrates another instance of the use of lettering on an architectural working drawing. The lettering defined by double lines is in this case a portion of the architectural design, the two letters on the pendant banners being sewn on to the cloth while those on the lower portion of the drawing are square-raised from the background and gilded. Single-line capitals are used in this example for the notes and information necessary to understand the meaning of the drawing.

A drawing of distinction should have a principal title of equal beauty, such as that shown in Fig. 5 or Fig. 7. The excellent lettering reproduced in Fig. 12, from a drawing by Mr. Claude Fayette Bragdon, is a strongly characteristic and individual form, although based on the same "skeleton" idea as the other types of single-line lettering already referred to.

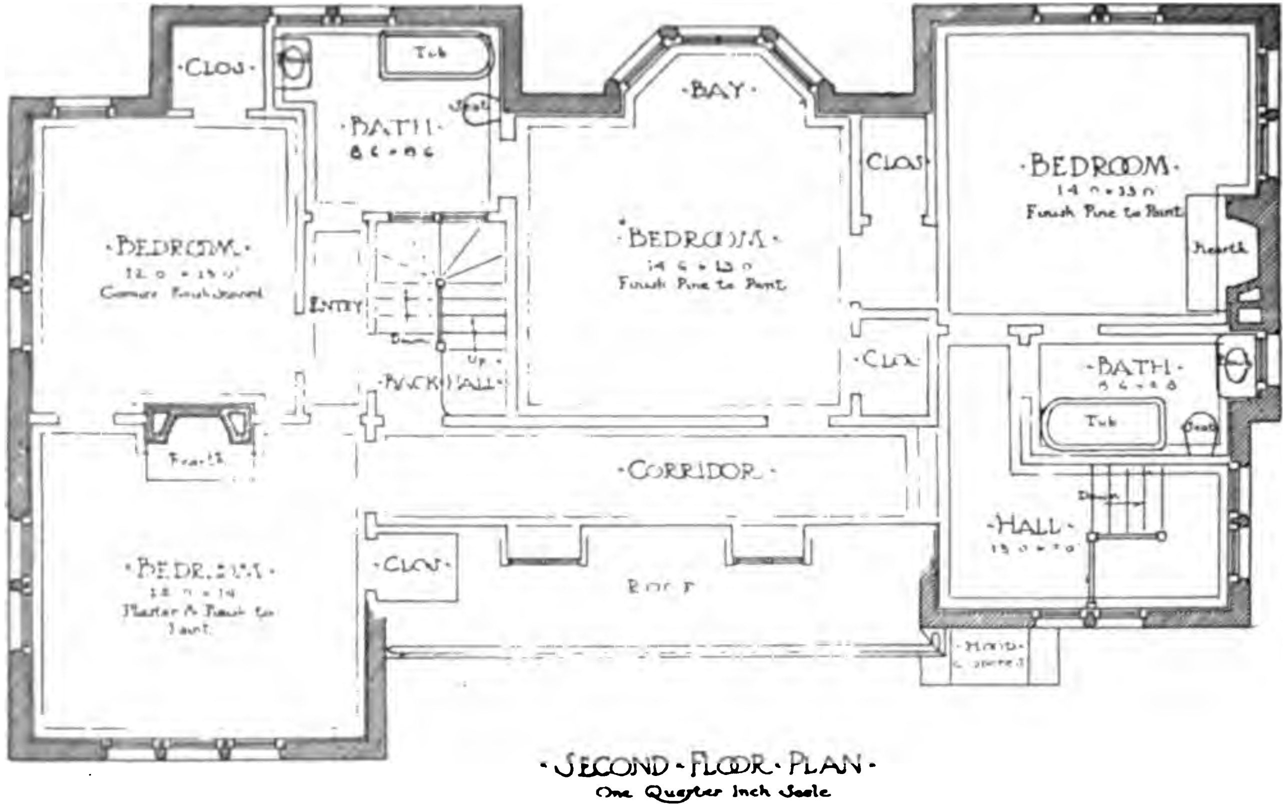


Fig. 13. Second-Floor Plan of Dwelling at Edgehill, New Hampshire, Showing Excellent Type of Architectural Lettering

Courtesy of Frank Chouteau Brown, Architect, Boston

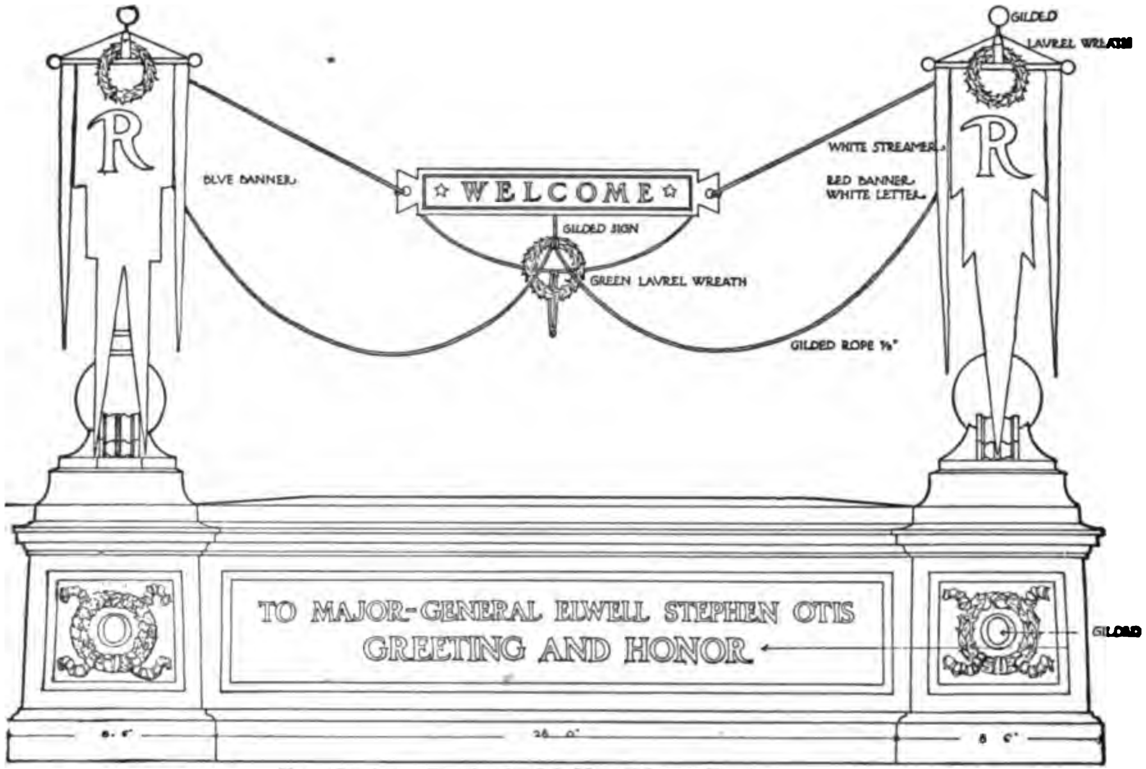
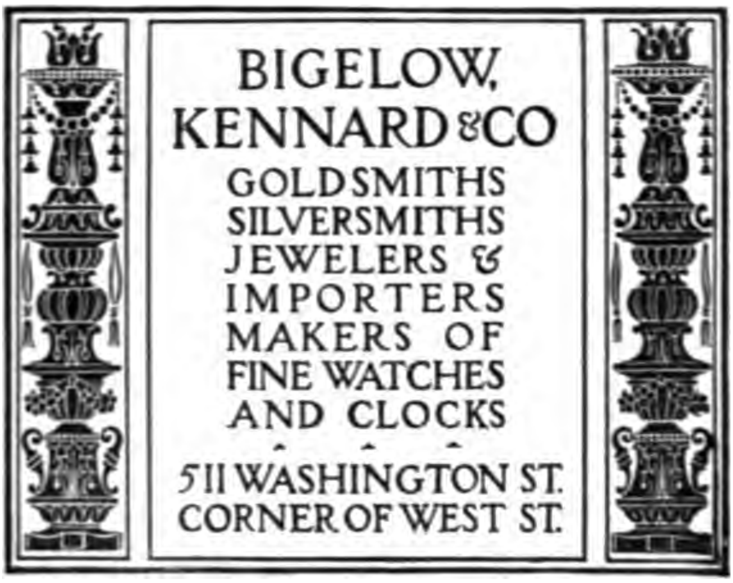


Fig. 11. Upper Portion of Drawing for Otis Memorial Arch Showing Excellent Style of Double Lettering

Courtesy of Claude Fayette Bragdon, Architect, Rochester, New York

The "skeleton" letter, formed on the classic Roman letter, displays quite as clearly as does the constructive system of Albrecht Durer, the distinctively *square* effect of the Roman capital. The entire Roman alphabet is built upon this square and its units. The letters shown in Figs. 22 and 23 are redrawn from rubbings of old marble inscriptions in the Roman Forum, and may be taken as representative of the best kind of classic letter for incision in stone. The Dürer letter, while a product of a later period, is fundamentally the same, and differs only in minor, if characteristic, details. However, for purposes of comparison it will serve to show the difference between a letter incised in marble, or in any other material, and one designed for use in lettering in black ink against a white background.

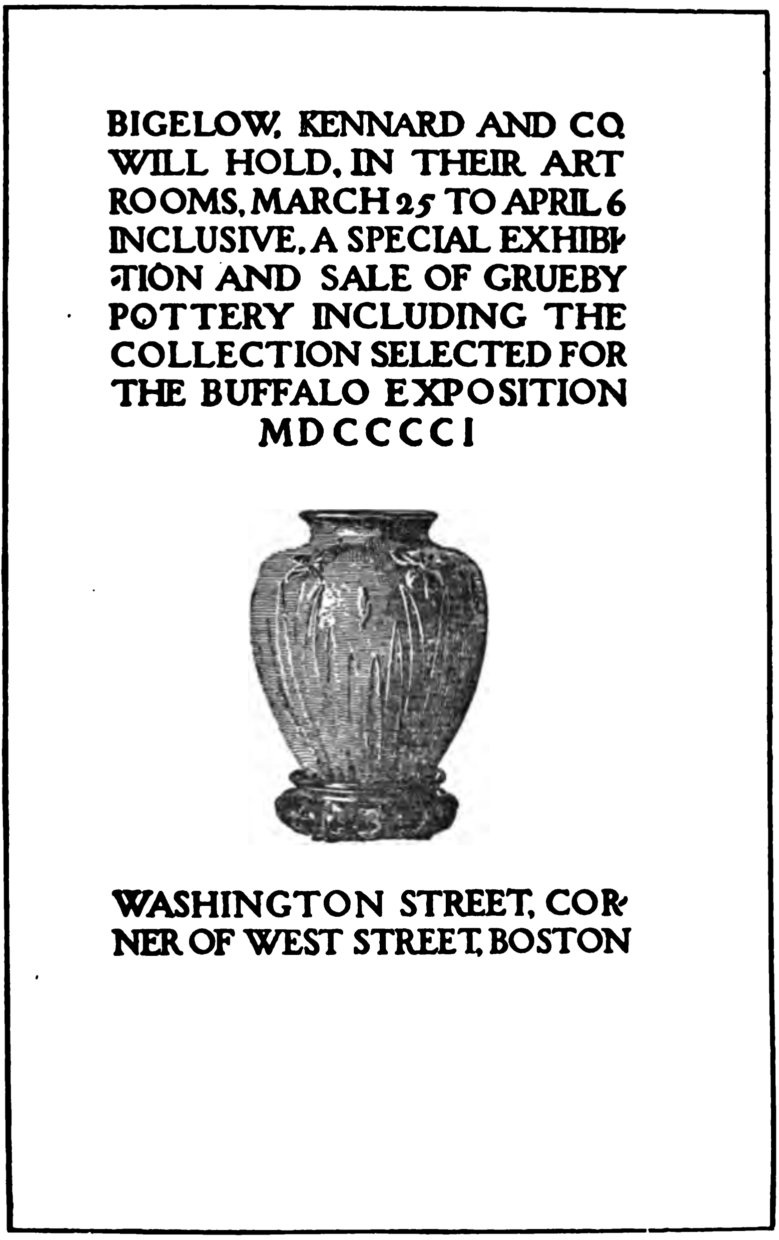

BIGELOW,
KENNARD & CO
GOLDSMITHS
SILVERSMITHS
JEWELERS &
IMPORTERS
MAKERS OF
FINE WATCHES
AND CLOCKS

511 WASHINGTON ST.
CORNER OF WEST ST.

Fig. 15. A Lettering Design, Showing Excellent Letter Composition and Spacing
Courtesy of Addison B. Le Boutillier

COMPOSITION.

After acquiring a sufficient knowledge of letter forms, the student is ready to begin the study of "lettering." While a knowledge of architectural beauty of form is the first essential, it



BIGELOW, KENNARD AND CO.
WILL HOLD, IN THEIR ART
ROOMS, MARCH 25 TO APRIL 6
INCLUSIVE, A SPECIAL EXHIBITION
AND SALE OF GRUEBY
POTTERY INCLUDING THE
COLLECTION SELECTED FOR
THE BUFFALO EXPOSITION
MDCCCCI

WASHINGTON STREET, CORNER
OF WEST STREET, BOSTON

Fig. 16. Cover Announcement Showing Excellent Letter Composition
Courtesy of Addison B. Le Boutillier

is not the vital part in lettering, for the *composition* of these separate characters is by far the most important part of the problem.

Composition in lettering is almost too intangible to define by any rule. All the suggestions that may be given are of necessity laid out on merely mathematical formulæ, and as such are incapable of equaling the result that may be obtained by spacing and producing the effect solely from artistic experience and intuition. The final result should always be judged by its effect upon the eye, which must be trained until it is susceptible to the slightest deviation from the perfect whole. It is more difficult to define what good composition is in lettering than in painting or any other of the more generally accepted arts, and it resolves itself back to the same problem. The eye must be trained by constant study of good and pleasing forms and proportions, until it appreciates instinctively almost intangible mistakes in spacing and arrangement.

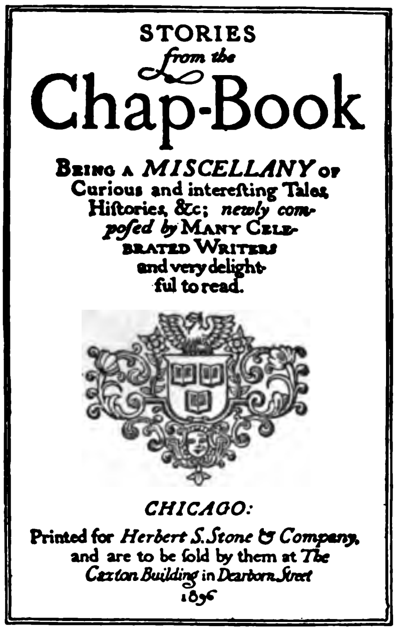
This point of "composition" is so important that a legend of most beautiful individual letter forms, badly placed, will not produce as pleasing an effect as an arrangement of more awkward letters when their composition is good. This quality has been so much disregarded in the consideration of lettering, that it is important the student's attention should be directed to it with additional force, in order that he may begin with the right feeling for his work.

An excellent example of composition and spacing is shown in Fig. 16, from a drawing by Mr. Addison B. Le Boutillier. The relation between the two panels of lettering and the vase form, and the placing of the whole on the paper with regard to its margins, etc., are exceptionally good, and the rendered shape of the vase is just the proper weight and color in reference to the weight and color of the lettered panels.

In this reproduction the border line represents the edge of the paper upon which the design itself was printed, and not a border line enclosing the panel. The real effect of the original composition can be obtained only by eliminating the paper outside of this margin and by studying the placing and mass of the design in relation to the remaining "spot" and proportions of the paper. Perhaps the simplest and most certain way to realize the effect of the original is to cut out a rectangle the size of this panel from a differently colored piece of paper, and place it over the page as a "mask," so that only the outline of the original design will show through.

The other example by the same designer, shown in Fig. 15, is equally good. The use of the letter with the architectural ornament, and the form, proportion, spacing and composition of the lettering are all admirable.

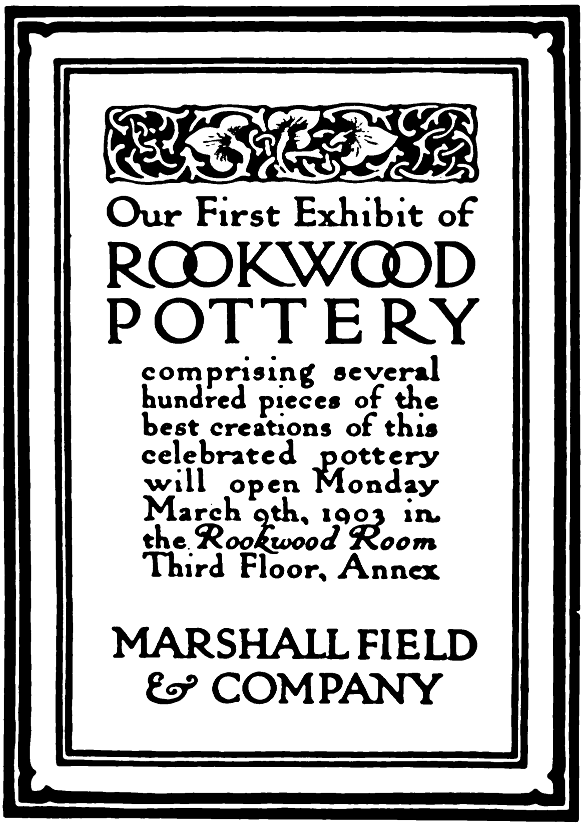
The title page, by Mr. Claude Fayette Bragdon, shown in Fig. 17, is a composition including the use of many different types of letters; yet all belong to the same period and style, so that an effect of simplicity is still retained. In composition, this page is not unlike its possible composition in type, but in that case no such variety of form for the letters would be feasible, while the entire design has an effect of coherence and fusion which the use of a pen letter alone makes possible, and which could not be obtained at all in typographical examples. The treatment of the ornament incorporated in this design should be noticed for its weight and rendering, which bear an exact relation to the "color" of the letter employed.


STORIES
from the
Chap-Book
BEING A *MISCELLANY* OF
Curious and intereſting Tales,
Hiſtories, &c; *newly com-*
poſed by MANY CELE-
BRATED WRITERS
and very delight-
ful to read.

CHICAGO:
Printed for *Herbert S. Stone & Company,*
and are to be ſold by them at *The*
Caxton Building in *Dearborn ſtreet*
1896

Fig. 17. Book Title Page
Courtesy of Claude Fayette Bragdon, Architect, Rochester, New York

In Fig. 18 is a lettered panel that will well repay careful study. The composition is admirable, the letter forms of great distinction—especially the small letters—and yet this example has not the innate refinement of the others. The decorative panel at the top is too heavy, and the ornament employed has no special beauty of form, fitness, or charm of rendering (compare Figs. 15 and 16). while the weight of the panel requires some such over-heavy border treatment as has been used. Here, again, in the slight Gothic cusping at the angles a lack of restraint or judgment on the part of the designer is indicated, this Gothic touch being entirely out of keeping with the lettering itself, and only partially demanded by the decorative panel. Of course, it is easy to see that these faults are all to be attributed to an attempt to attract and hold the eye and thus add to the value of the design as an advertisement; but a surer taste could have obtained this result and yet not at the expense of the composition as a whole. It is nevertheless an admirable piece of work.



Our First Exhibit of
ROOKWOOD
POTTERY
comprising several
hundred pieces of the
best creations of this
celebrated pottery
will open Monday
March 9th, 1903 in
the *Rookwood Room*
Third Floor, Annex

MARSHALL FIELD
& COMPANY

Fig. 18. Advertising Announcement with Excellent Lettering Composition

In Fig. 19 is shown an example of the use of lettering in composition, in connection with a bolder design, in this case for a book cover, by Mr. H. Van Buren Magonigle. Note the nice sense of relation between the style of lettering employed and the design itself, as well as the subject of the work. The letter form is a most excellent modernization of the classic Roman letter shape (compare Figs. 22 and 23).

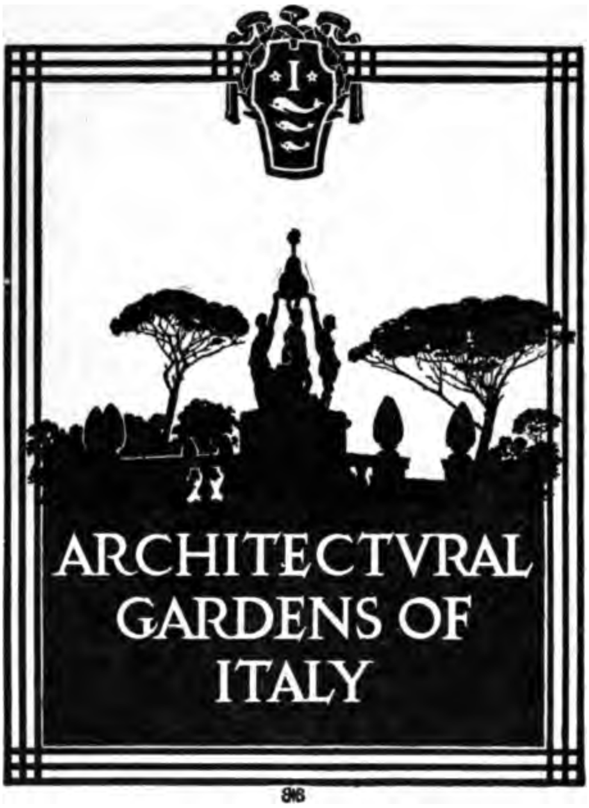


Fig. 19. Book Cover
Courtesy of H. Van Buren Magonigle

The student must be ever appreciative of all examples of the good and bad uses of lettering that he sees, until he can distinguish the niceties of their composition and appreciate to the utmost such examples as the first of these here shown. It is only by constant analysis of varied examples that he can be able to distinguish the points that make for good or bad lettering.

SPACING.

There is a workable general rule that may be given for obtaining an *even* color over a panel of black lettering; that is, if the individual letters are so spaced as to have an equal area of white between them this *evenness* of effect may be attained. But when put to its use, even this rule will be found to be surrounded by pitfalls for the unwary. This rule for spacing must not be understood to mean that it applies as well to *composition*. It does not: it is, at the best, but a makeshift to prevent one from going far wrong in the general tone of a panel of lettering, and must therefore fully apply only to a legend employing one single type of letter form.

One with sufficient authority and experience to give up dependence upon merely arbitrary rules, and to rely upon his own judgment and taste may, by varying sizes and styles of letters, length of word lines,etc.,obtain a finer and much more subtle effect.

To acquire this authority in modern lettering it is necessary to observe and study the work turned out today by the best designers and draftsmen, such as the drawings of Edward Penfield, Maxfield Parrish, A. B. Le Boutillier and several others. The architectural journals, also, publish from month to month beautifully composed and lettered scale drawings by such draftsmen as Albert R. Ross, H. Van Buren Magonigle, Claude Fayette Bragdon, Will S. Aldrich and others, who have had precisely the same problem to solve as is presented to the draftsman in every new office drawing that he begins.

Of course, the freer and the further removed from a purely Classic capital form is the letter shape employed by the draftsman, the less obliged is he to follow Classic precedent; but at the same time he will find that his drawing at once tends more toward the bizarre and eccentric, and the chances are that it will lose in effectiveness, quietness, legibility and strength.

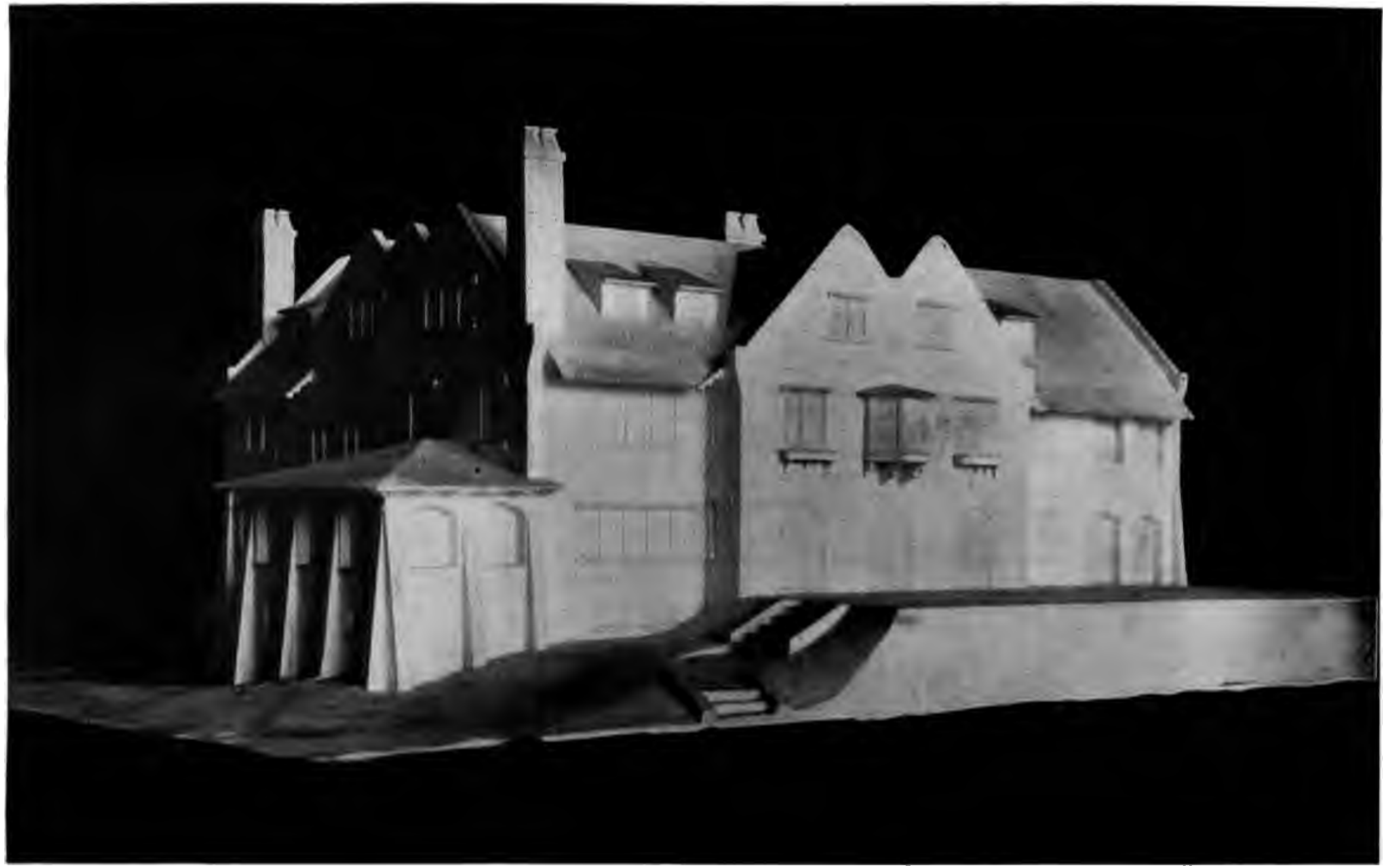
The student will soon find that he unconsciously varies and individualizes the letters that he constantly employs, until they become most natural and easy for him to form. This insures his developing a characteristic letter of his own, even when at the start he bases it upon the same models as have been used by many other draftsmen.

MINUSCULE OR SMALL LETTERS.

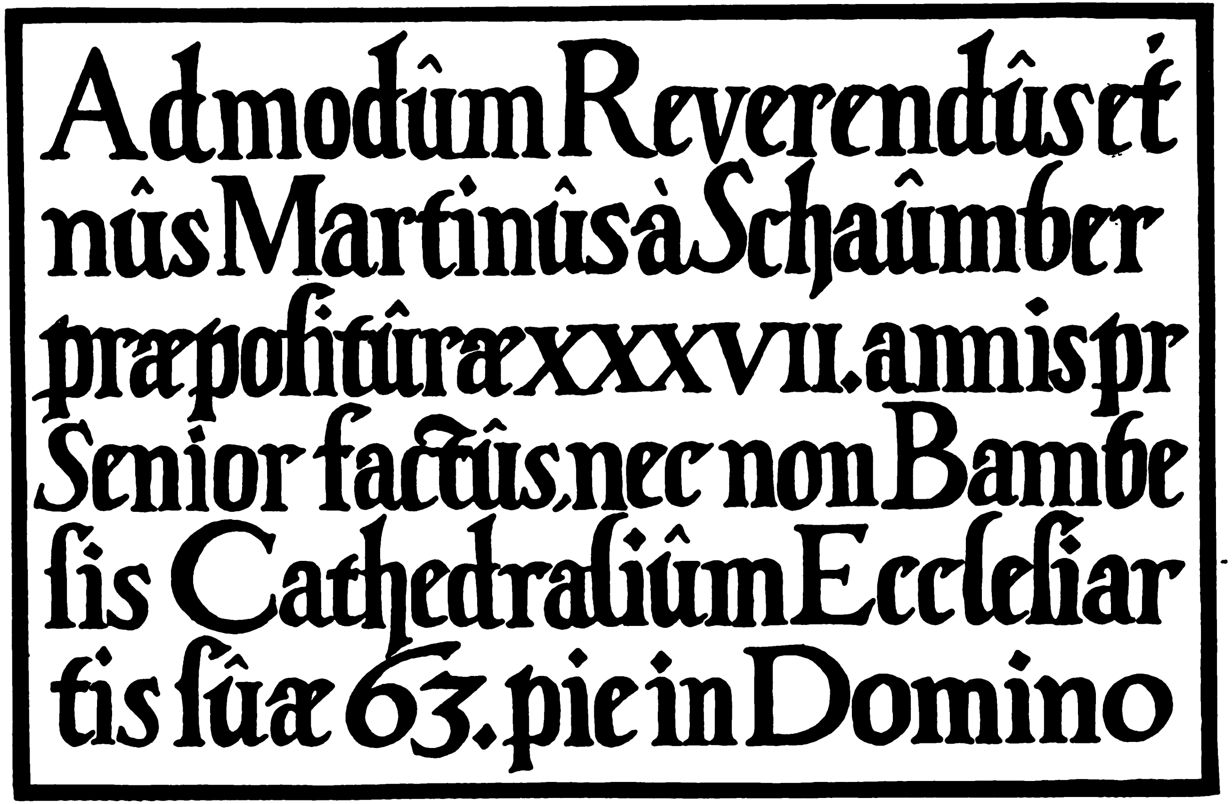
In taking up the use of the small or minuscule letter, a word of warning may be required. While typographical work may furnish very valuable models for composition and for the individual shapes of minuscule letters, they should never be studied for the *spacing* of letters, as such spacing in type is necessarily arbitrary, restricted and often unfortunate. Among the lower case types will be found our best models of individual minuscule letter forms, and the Caslon old style is especially to be commended in this respect; but in following these models the aim must be to get at and express the essential characteristics of each letter form, to reduce it to a "skeleton" after much the same fashion as has already been done with the capital letter, rather than to strive to copy the inherent faults and characteristics of a type-minuscule letter. The letter must become a "pen form" before it will be appropriate or logical for pen use; in other words, the necessary limitations of the instrument and material must be yielded to before the letter will be amenable to use for lettering architectural drawings.

The small letters shown in Figs. 17, 18 and 20 are all adapted from the Caslon or some similar type form, and all exhibit their superiority of spacing over the possible use of any type letter. Fig. 20 is a particularly free and beautiful example indicating the latent possibilities of the minuscule form that are as yet almost universally disregarded. An instance of the use of the small letter shown in a complete alphabet in Fig. 10, may be seen in Figs. 9 and 13.

In lettering plans for working drawings, the small letter is used a great deal. All the minor notes, instructions for the builders or contractors, and memoranda of a generally unimportant character, are inscribed upon the drawing in these letters. Referring again to Fig. 10, the letters at the top of the page would be those used for the principal title, the name of the drawing, the name of the building or its owner, while the outline capitals would be used in the small size beneath the general title, to indicate the scale and the architect, together with his address. In a small building, or one for domestic use, these same letters would be employed in naming the various rooms, etc., although in an

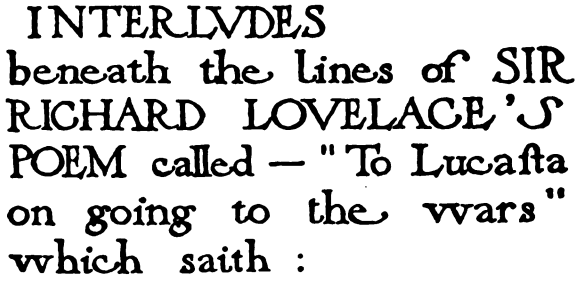


ARCHITECT'S MODEL OF RESIDENCE FOR MR. FRED PABST ON OCONOMOWOC LAKE, WISCONSIN
Fernekes and Cramer, Architects, Milwaukee, Wisconsin; Newton Engineering Company, Engineers
All walls and partitions are of reinforced concrete. Exterior walls not plastered but have a hammered finish.


Admodûm Reverendûs et
nûs Martinûs à Schaûmber
præpoſitûræ XXXVII. annis pr
Senior factûs, nec non Bambe
ſis Cathedraliûm Eccleſiar
tis ſûæ 63. pie in Domino

MINUSCULE LETTERING FROM A HAND-LETTERED INSCRIPTION IN BRONZE IN THE CATHEDRAL AT BAUMBERG, 1613 elaborate ornamental or public building, letters similar to those in the principal title might be better used, while the minuscule letter would be utilized for all minor notes, memoranda, directions, etc. By referring to Figs. 3, 5, 7, 8, 9, 13 and 14, examples from actual working drawings and plans are shown, which should sufficiently indicate the application of this principle.

It must again be emphasized that practice in the use of these forms combined together in words, as well as in more difficultly composed titles and inscriptions where various sizes and kinds of letters are employed, is the only method by which the draftsman can become proficient in the art of lettering; and even then he must intelligently study and criticise their effect after they are finished, as well as study continually the many good drawings carrying lettering reproduced in the architectural journals. For this purpose, in order to keep abreast of the modern advance in this requirement, he must early learn to distinguish between the instances of good and bad composition and lettering.



INTERLVDES
beneath the lines of SIR
RICHARD LOVELACE'S
POEM called — "To Lucasta
on going to the wars"
which saith :

Fig. 20. Pen-Drawn Heading
Courtesy of Harry Everett Townsend

ARCHITECTURAL INSCRIPTION LETTERING.

The use of a regular Classic letter for any purpose necessitates the reversion to and the study of actual Classic examples for spacing and composition. In using this letter in a pen-drawn design, certain changes must be made in adapting it from the incised stone-cut form—which variations are, of course, practically the reverse of those required in first adapting the letter for use in stone. The same letter for stone incision requires, in addition, a careful consideration of the nature of the material, and the spacing and letter section that it allows. Also the effect

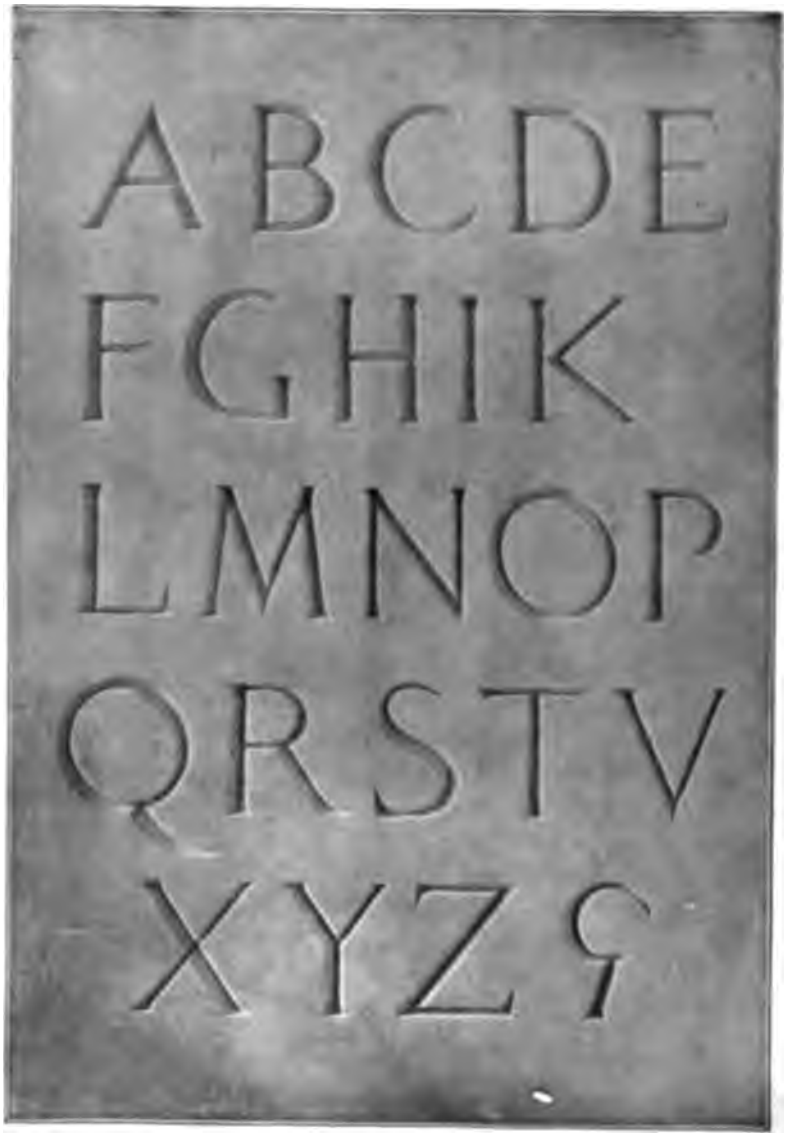


Fig. 21. Scale for Lettering on Granite Frieze of Boston Public Library
McKim, Mead & White, Architects, New York City

of a letter in the inscription in place must be carefully studied, its height above or below and relation to the eye of the observer. The fact is that the letter form must in this case be determined solely by the light and shadow cast by the sun on a clear, bright day, or diffused more evenly on a cloudy one. If in an interior location its position in regard to light and view-point is even more important, as the conditions are less variable.

CLASSIC ROMAN LETTERS.

In any letter cut in stone, or cast in metal, it is not the outline of the letter that is seen by the eye of the observer, but the *shadow* cast by the *section used to define the letter.* This at once changes the entire problem and makes it much more complicated. In incising or cutting a letter into an easily carved material, such as stone or marble, we have the examples left us by the inventors, or at least the adapters, of the Roman alphabet. They have generally used it with a V-sunk section, and in architectural and monumental work this is still the safest method and the one most generally followed. One improvement has been made in adapting it to our modern conditions. The old examples were most often carved in a very fine marble which allowed a deep sinkage at a very sharp angle, thus obtaining a well-defined edge and a deep shadow. In most modern work the letters are cut in sandstone or even in such coarse material as granite, where sharp angles and deep sinkage of the letter-section is either impossible, or for commercial reasons influencing both contractors and stonecutters, very hard to obtain. To counterbalance this fault a direct sinkage at right angles to the surface of the stone before beginning the V section has been tried, and is found to answer the purpose very well, as it at once defines the edge of the letter with a sharp shadow. See the two large sections shown in the upper part of Fig. 31.

This section requires a letter of pretty good size and width of section, and, therefore, may be used only on work far removed from the eye, as is indeed alone advisable. An inscription that is to be seen close at hand must rely upon the more correct section and be cut as deeply as possible. For lettering placed at a great height, an even stronger effect may be obtained by making the incised section square, and sinking it directly into the stone.

Such pleasant grading of shadows as may be attained by the other method is then impossible, and there are no subtle cross lights on the rounding letters to add interest and variety, but the letter certainly carries farther and has more strength

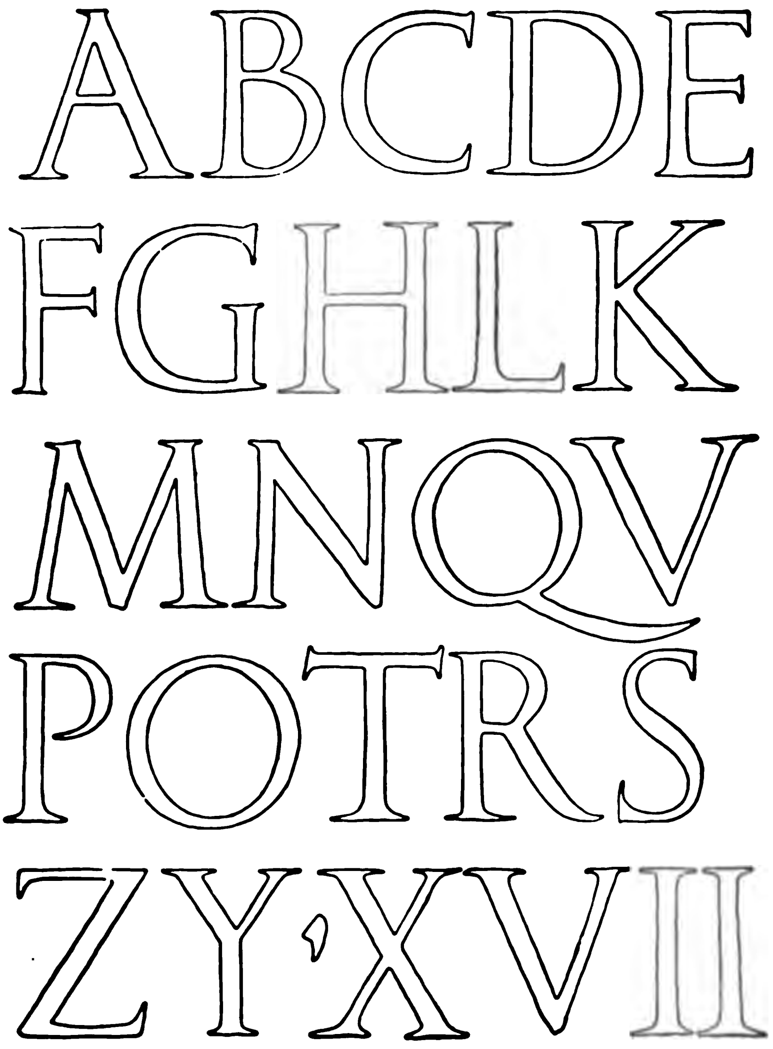


Fig. 22. Classic Roman Alphabet Taken from Marble Inscription in Roman Forum

In Fig. 21 is shown a photograph from a model of the incised V-sunk letters cut in granite on the frieze of the Boston

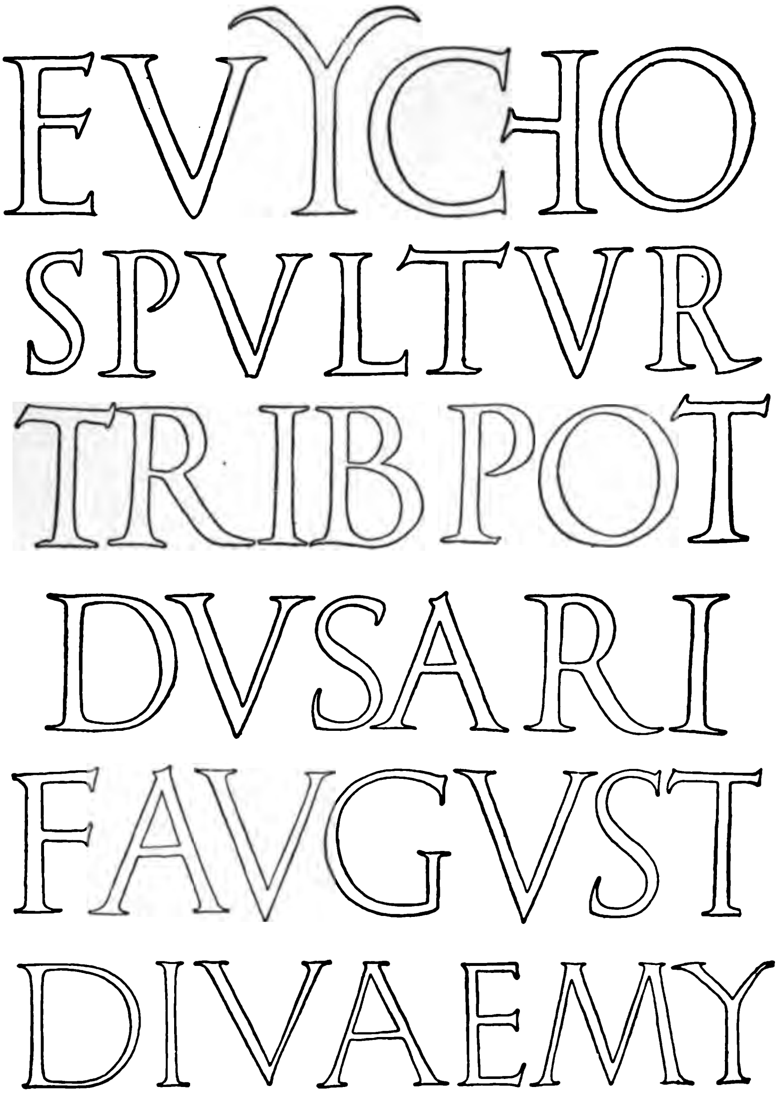


Fig. 23. Fragments of Classic Roman Inscriptions

Public Library. This photograph indicates the shadow effect that defines the incised form of the letter, and will assist the student somewhat in determining the section required for the best effect. It will be observed that this letter is different in character from the one used by the same architects in a different material, sandstone, shown in Fig. 24.

In Fig. 22 is shown an alphabet redrawn from a rubbing of Roman lettering, and in Fig. 23 are shown portions of Classic inscriptions where letters of various characters are indicated. These letters were very sharply incised with a V-sunk section in marble, and were possibly cut by Greek workmen in Rome. It is on some such alphabet as this that we must form any modern letter to be used in a Classic inscription or upon a Classic building. These forms should be compared with the letters shown in Fig. 24, on the Architectural Building at Harvard, by McKim, Mead & White, architects, where they were employed with a full understanding of the differences in use and material. The Roman letter was cut in marble; the modern letter in sandstone. Both were incised in the V-sunk section, but the differences in material will at once indicate that the modern letter could not have been cut as clearly nor as deeply as the old one. The modern letter was done a little more than twice the original size of the old one, which explains certain subtleties in its outline as here drawn. The sandstone being a darker material than the marble, the letter should of necessity be heavier and larger in the same location, in order to "carry" or be distinguishable at the same distance; while the Classic example, being sharply and deeply cut in a beautiful white material which even when wet retains much of its purity of color, would be defined by a sharper and blacker outline, and therefore be more easily legible, other conditions being the same, even for a longer distance. In both these figures, the composition of the letters may be seen to advantage, as in even the Classic example, where they are alphabetically arranged, they are placed in the same relation to each other as they held in the original inscription. A complete alphabet of the letter shown in word use in Fig. 24, is shown at larger size in Fig. 25.

Although the lettering of the Italian Renaissance period was modeled closely after the Classic Roman form, it was influenced by many different considerations, styles and peoples.

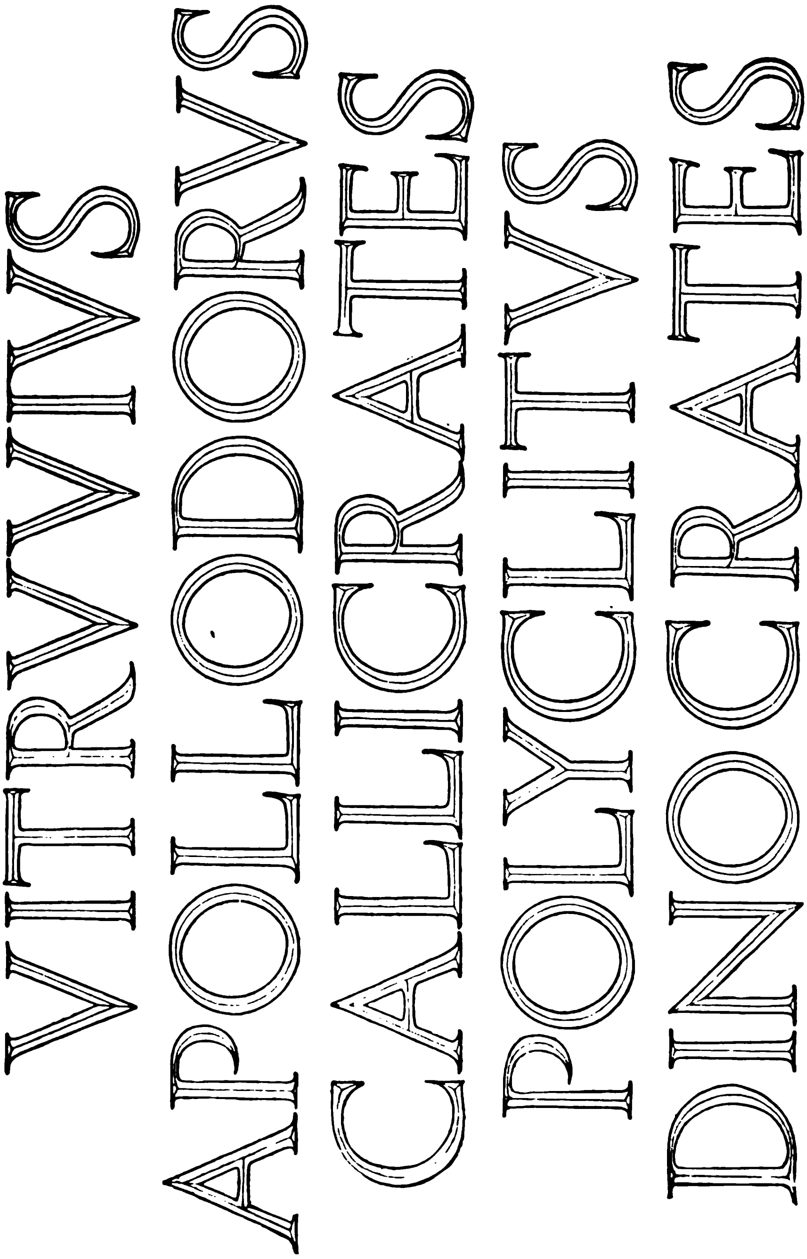
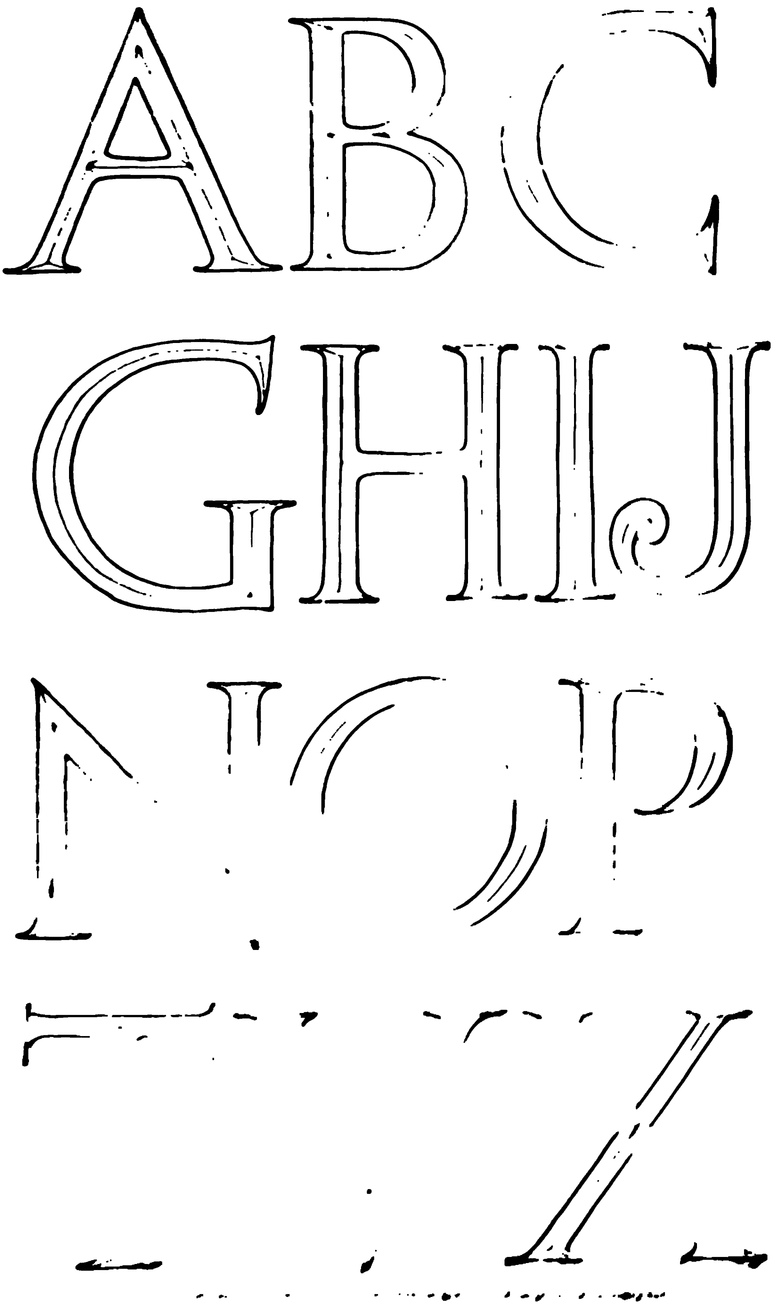


Fig. 21. Lettering as Used on the Harvard Architectural Building
Courtesy of McKim, Mead, and White, Architects, New York City


A B C
G H I J
N O P
Z

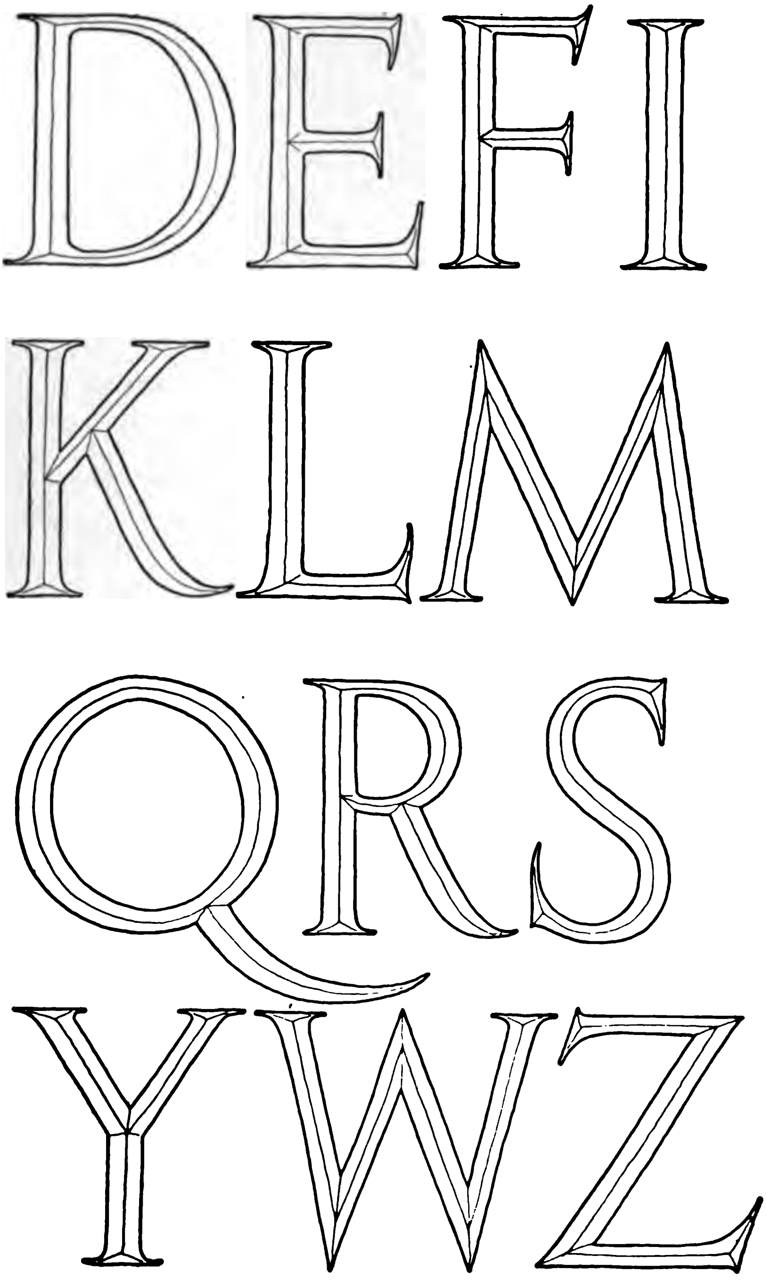


Fig. 25. Letters Shown in Fig. 24 Enlarged for Purpose of Analysis

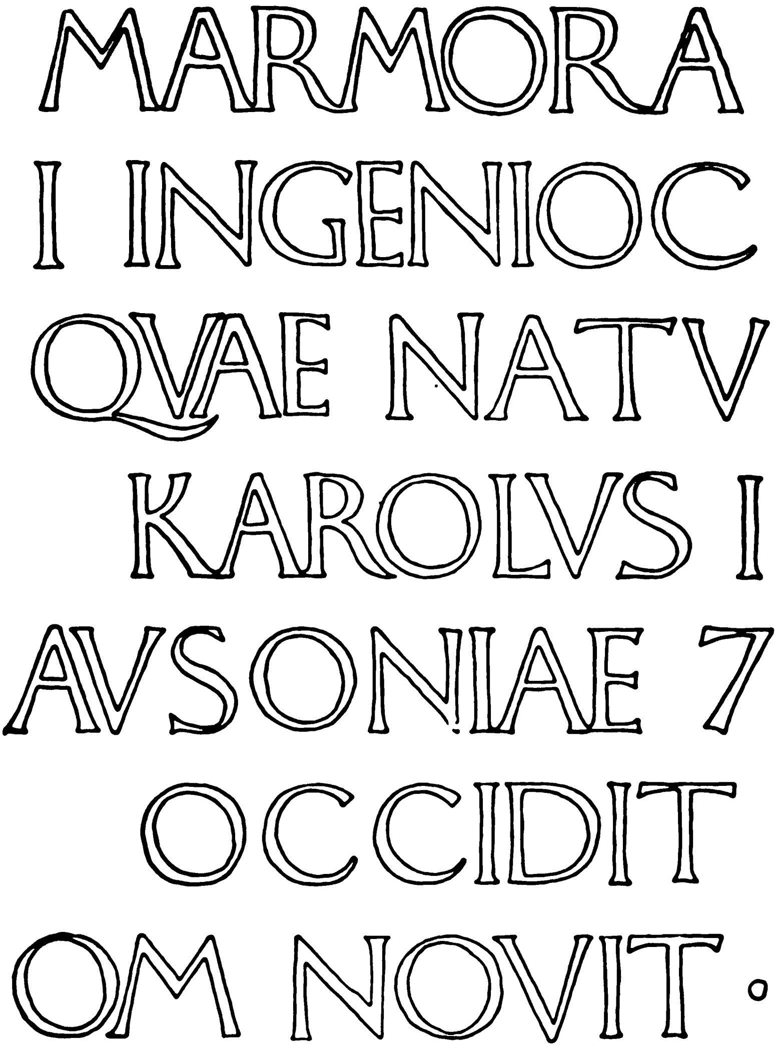
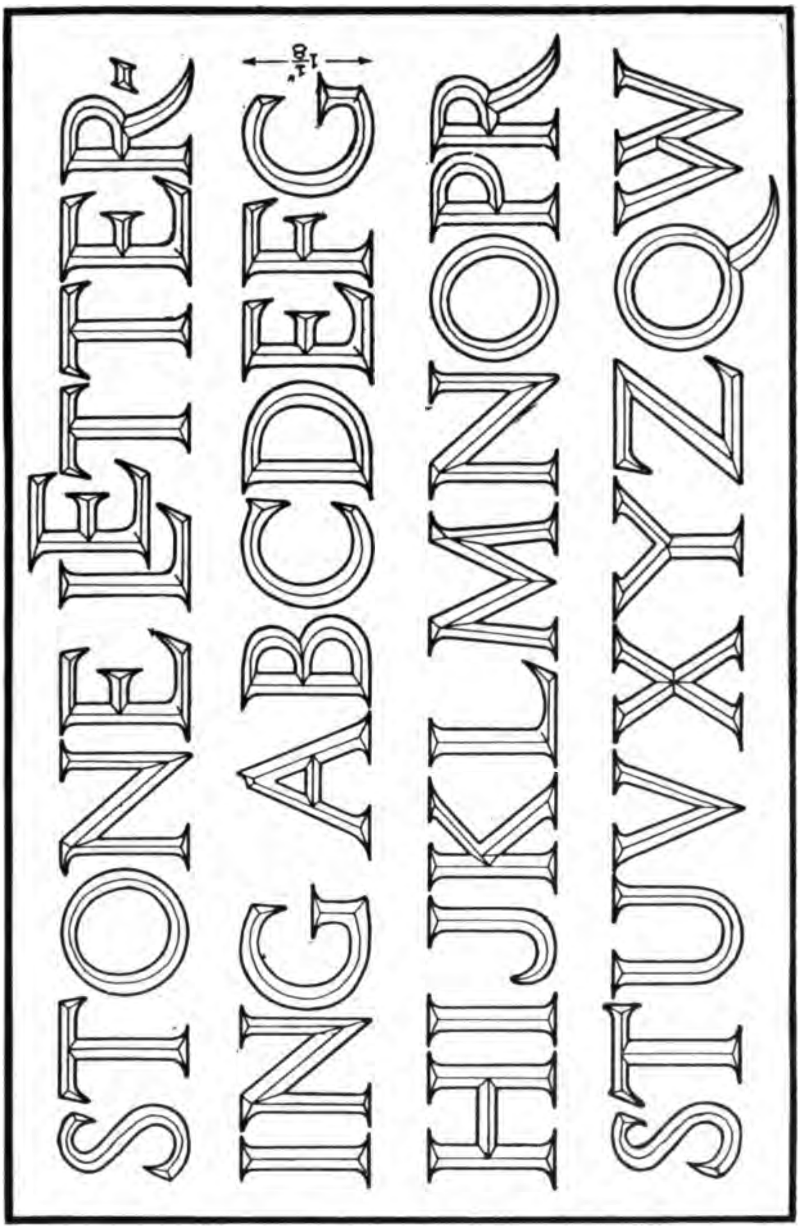
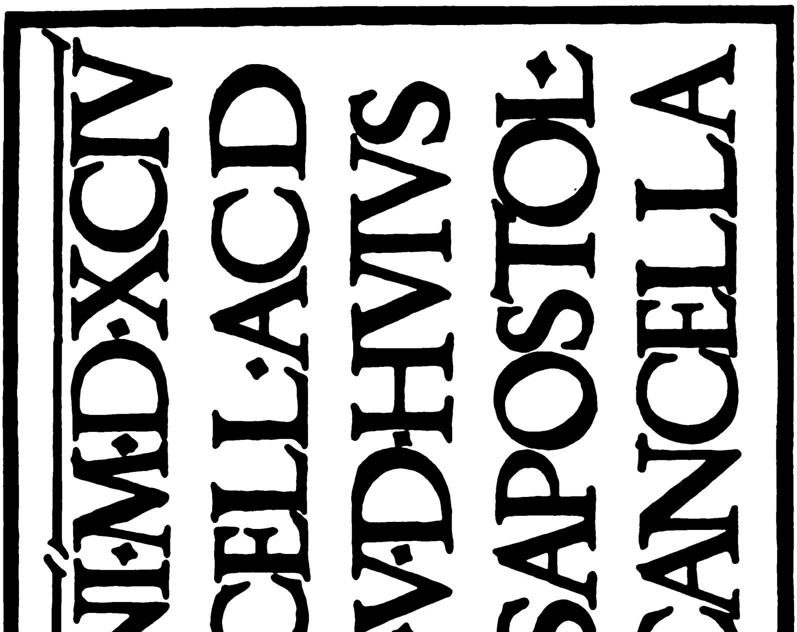


Fig. 26. Fragment of Italian Renaissance Inscription from the Marsuppini Tomb in Florence.



ALPHABET OF MODERN CAPITAL LETTERS OF ITALIAN RENAISSANCE CHARACTER
Suitable for cutting at a small size (i.e., 1¾ inches high) in stone



LETTERING FROM BRONZE PLATE IN CATHEDRAL CHURCH AT WURZBURG, 1594

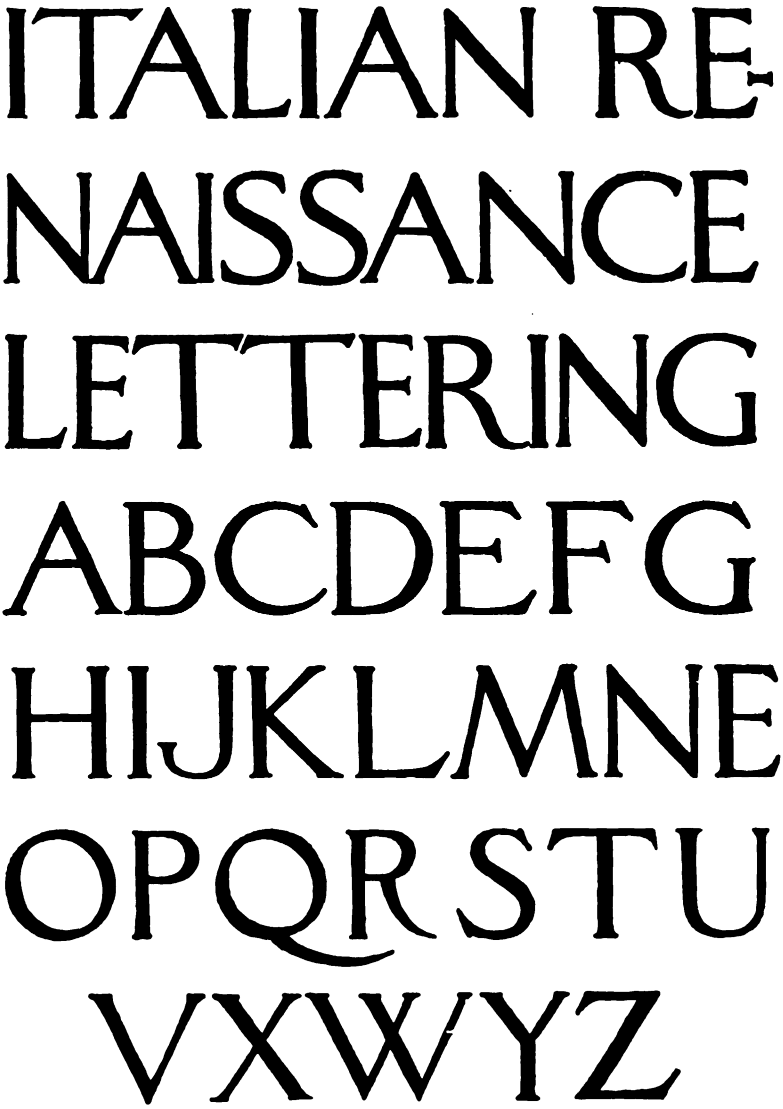


Fig. 27. Italian Renaissance Lettering Adapted from Inscription Shown in Fig. 26

In Fig. 26 is shown a fragment of the inscription on the Marsuppini tomb at Florence. This outline letter was traced from a rubbing, and shows very nearly the exact character of the original, a marble incised letter. Fig. 27 is an alphabet devised from this incised letter for use as a pen-drawn form and redrawn at the same size. It will be noticed that in the letters shown in the four lower lines a quite different serif* treatment has been adopted, and certain of the letters, such as the E's, have been "extended" or made wider in proportion. These variations are such as modern taste would generally advocate, but in the first three lines of this plate the feeling, serif treatment and letter width of the original have been retained; the only change has

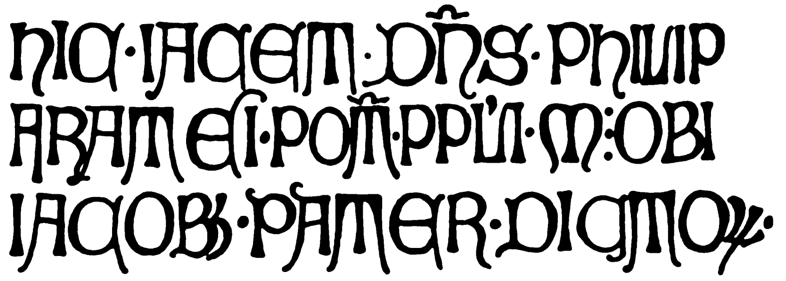


Fig. 28. Italian Renaissance Inscription at Bologna

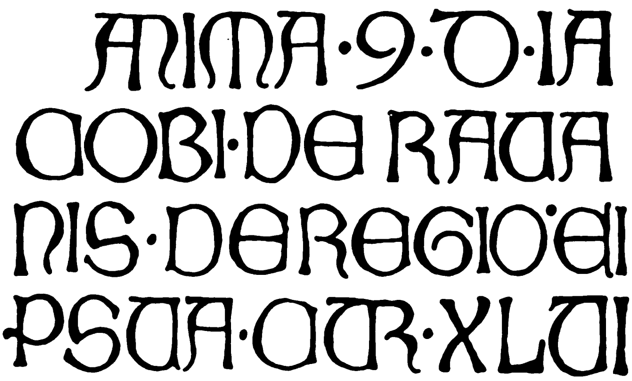


Fig. 29. Italian Renaissance Inscription at Chiaravalle Abbey, Milan

---

*Note. The "serif" is the short spur or cross stroke used to define and end the main upright and horizontal lines of the letter.

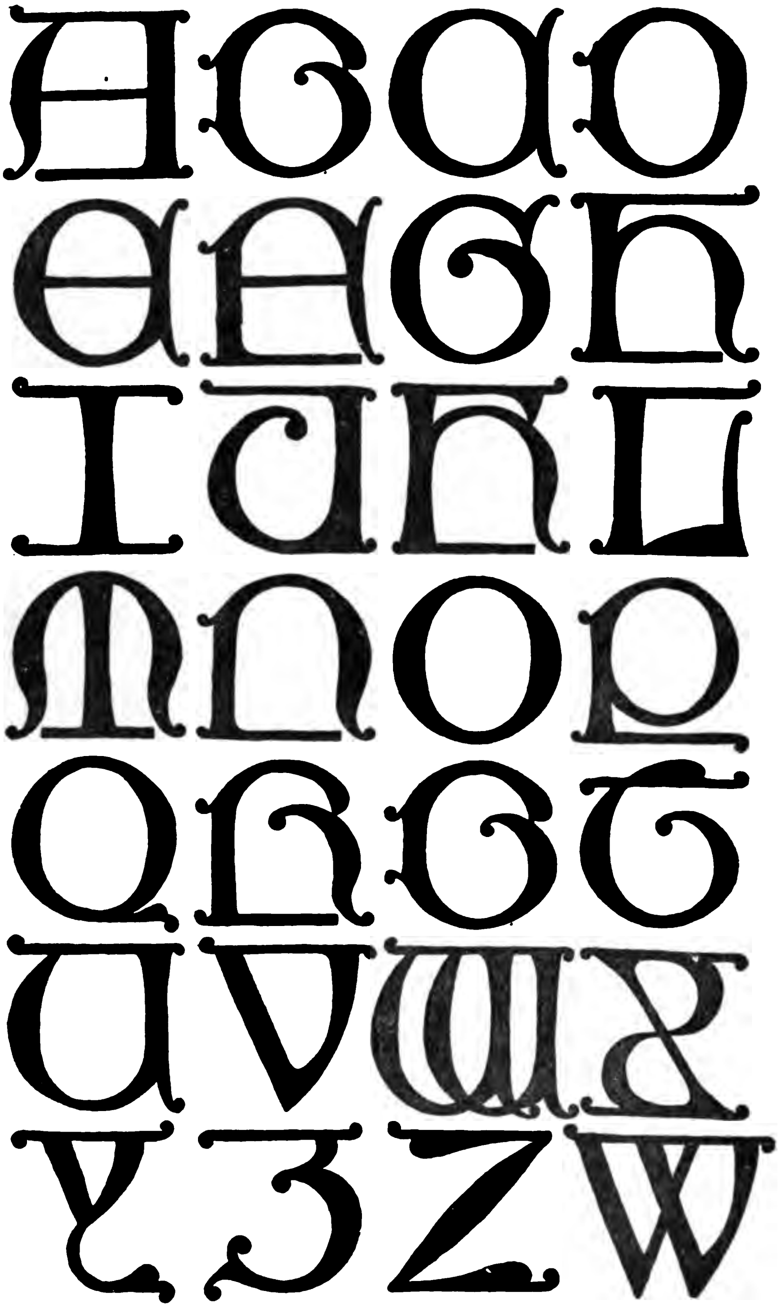
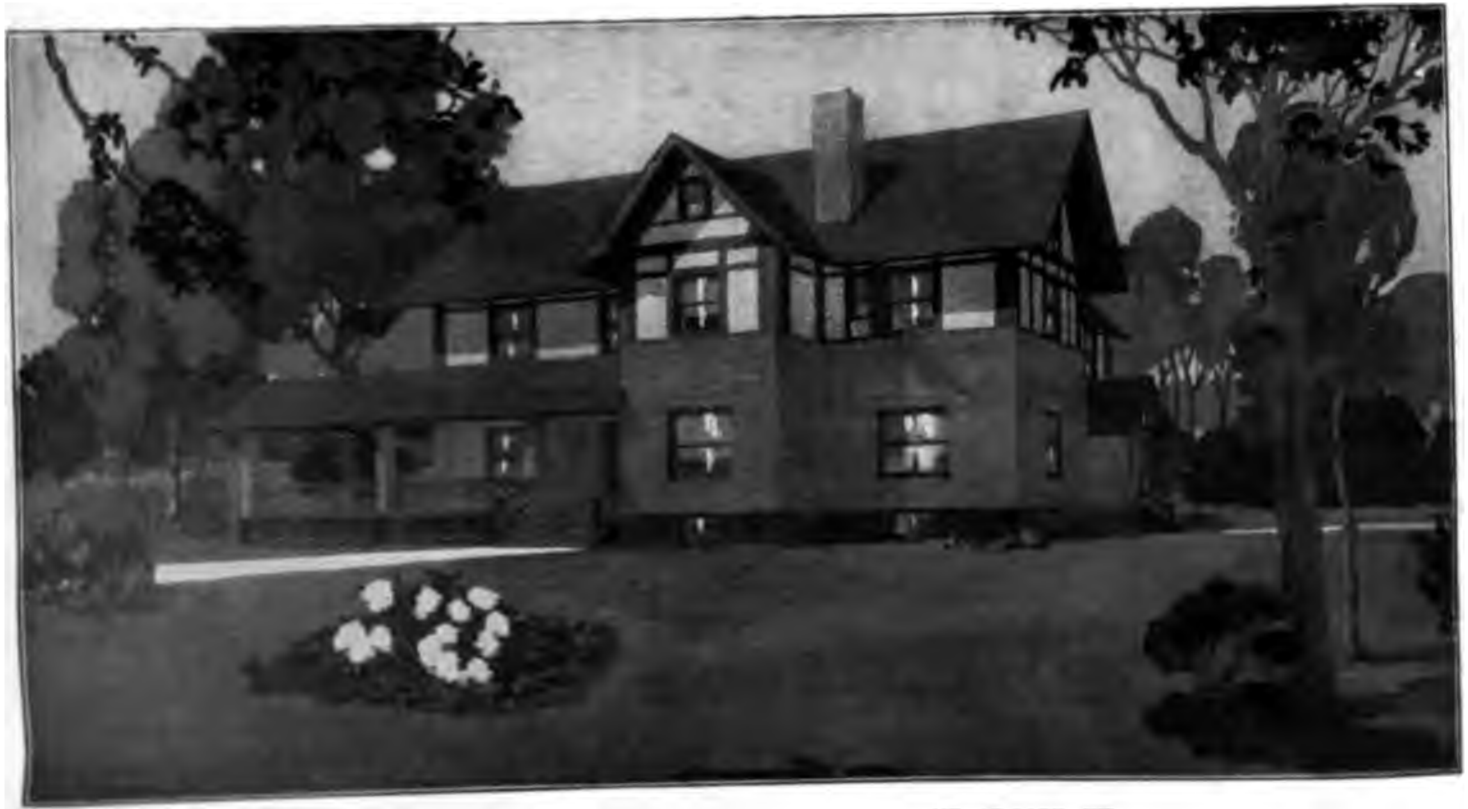


Fig. 30. Alphabet of Uncial Gothic Capital Letters, Sixteenth Century



HOUSE FOR SUPERINTENDENT OF INDIANA STEEL COMPANY, AT GARY, IND.

Dean & Dean, Architects, Chicago, Ill.

been to narrow up the thin lines in relation to the thick lines to the proportions that they should have in a solidly black and inked-in letter form.

The two small panels, one from a monument in Bologna, and one from the Chiaravelle Abbey in Milan, Figs. 28 and 29, show a letter which was incised in stone and follows the so-called uncial or round form, with characteristics showing the probable influence of the Byzantine art and period. These two inscriptions may be compared with another alphabet showing the uncial character when used in black against a white page, as in Fig. 30. This same style of letter was often used in metal, and may be seen in many of the mortuary slabs of this and succeeding periods.

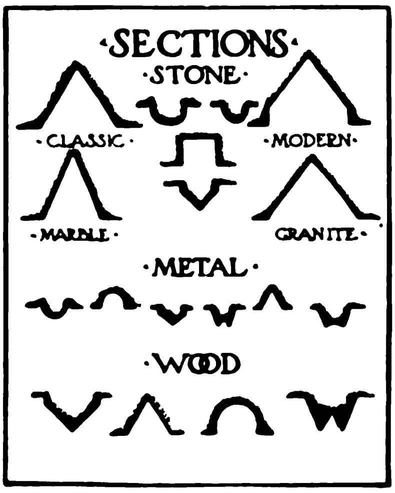


Fig. 31. Types of Letter Sections

In many of the Renaissance wall monuments the V-sunk letter sections have been filled with a black putty to make the letter very clear, and when this falls out, as it often does, the V cut section may still be seen behind it. Also in many Italian floor slabs the letters are either V sunk or shallow, square sinkages filled with mastic, or sometimes they are of inlaid marble of a color different from the ground. Again a V-sunk letter section sometimes carries an additional effect because it is smoothly cut

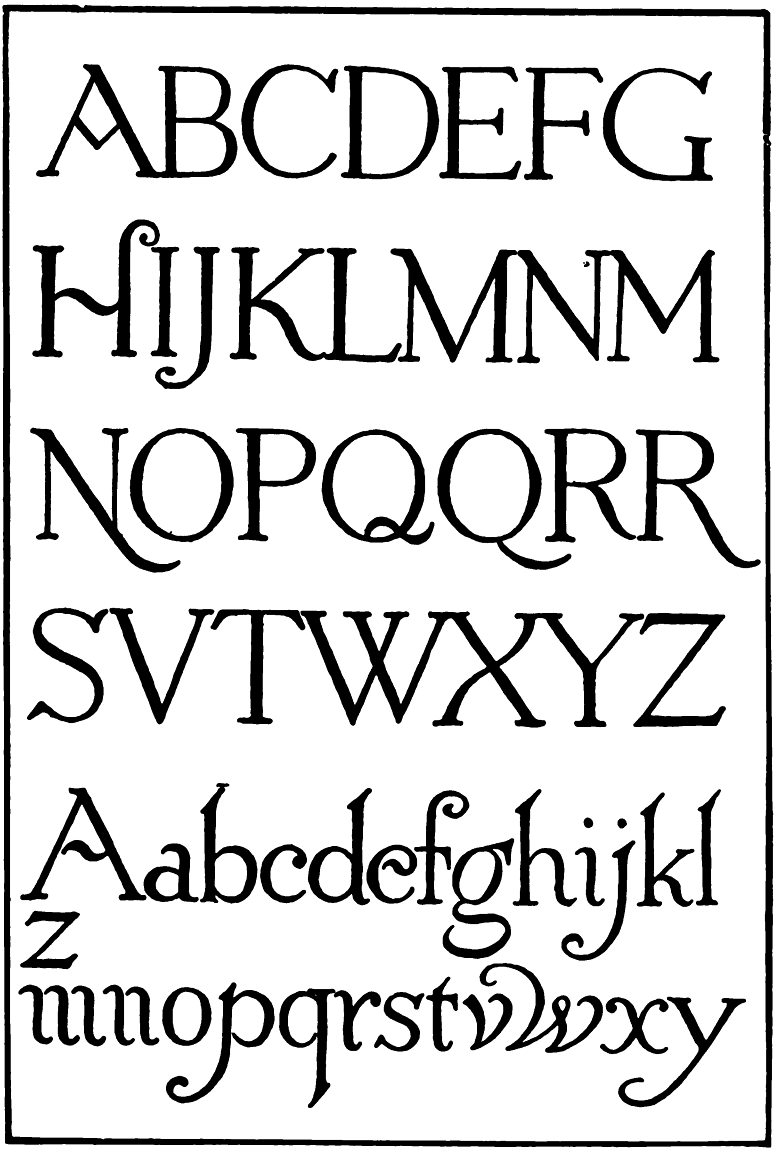


Fig. 32. Typical English Seventeenth Century Letters, Taken from Tombstones

and finished and the surface of the stone is left rough, thus obtaining a different texture and color effect; or, though more rarely, the opposite treatment may be used. Then, again, the sides of the letter sinkage may be painted or gilded. Often even the shadow is painted into the section, but this is generally done on interior cutting where there is no direct light from the sun, because if direct sunlight does fall upon a letter so treated, a very amusing effect occurs when the shadow is in any other position than that occupied by the painted representation.

For still further effects, *raised lettering* may be cut on stone surfaces. This is more expensive, as it necessitates the more labor in cutting back the entire ground of the panel, but for certain purposes it is very appropriate.

In such a letter the section may be a raised V-shape, or it may be rounded over to make a half circle in section, as drawn in Fig. 31. This latter form is especially effective in marble, but it is, of course, very delicate and does not carry to any great distance. Its use should be restricted to small monumental headstones or to lettering to be read close to, and below the level of, the eye.

A raised letter is more generally appropriate for cast copper and bronze tablets, when its section may be a half round, a raised V-form, or square-raised with sharp corners; or, better still, a combination of square and V raised with a hollow face. See Fig. 31. Experience has proved that this last-named section produces the most telling letter for an ordinary cast-metal panel.

Fig. 32 shows an alphabet of a letter derived from English tombstones. This letter was cut in slate or an equally friable material, and was comparatively shallow. A certain tendency toward easing the acute angles may be observed in this alphabet, evidently on account of the nature of the material in which it was carved rendering it easily chipped or broken.

In wood carving, a letter exactly reversing the V-sunk section with direct sinkage, gives the best effect for a raised letter.

Every material, from its nature and limitations, requires special consideration. A letter with many angles is not adapted to slate, as that material is liable to chip and sliver; hence an

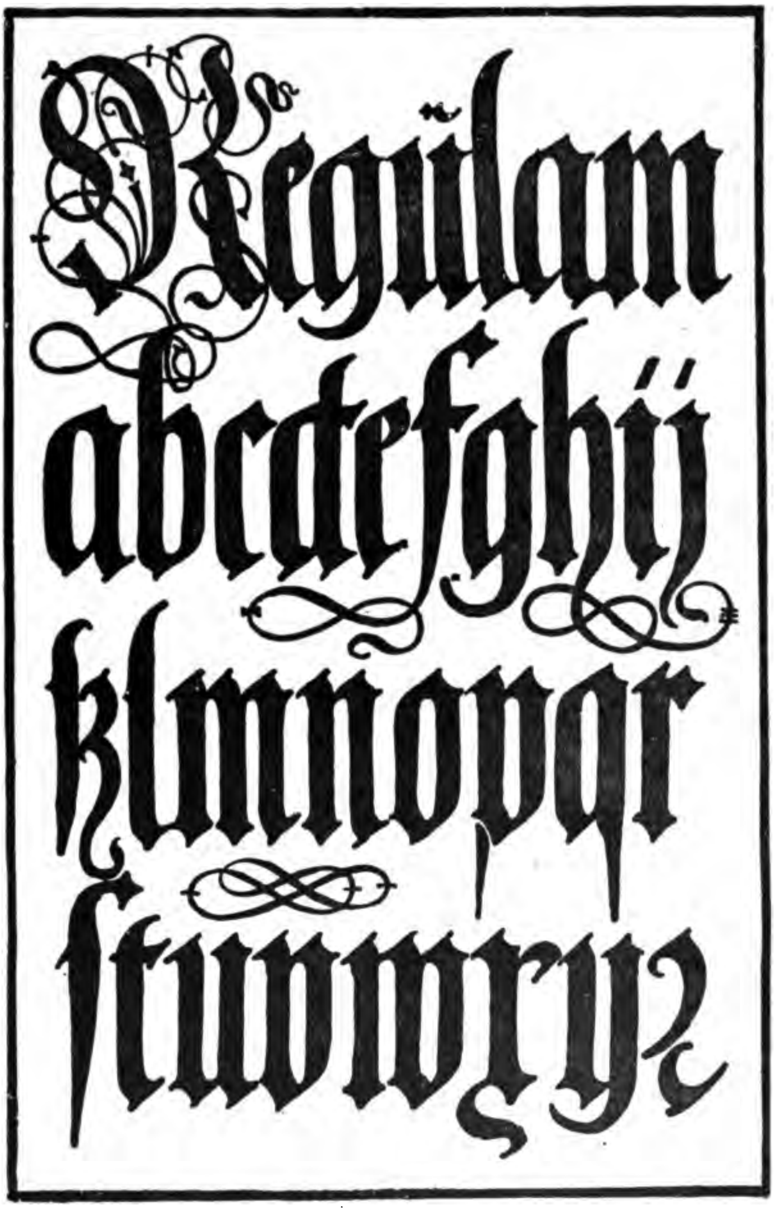
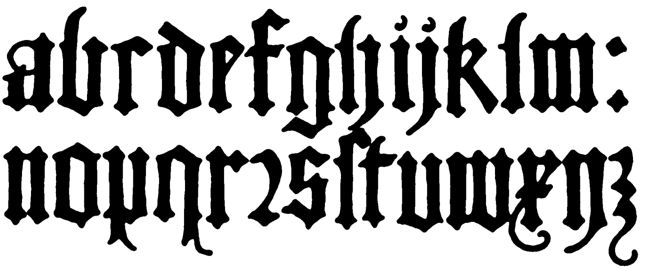


Fig. 33. Typical German Black Letters, Taken from a Brass Tablet

uncial form with rounded angles suggests itself (as in Fig. 29), and is, indeed, frequently used.

It would be quite impossible to take up in detail the entire list of available materials and consider their limitations at length, as the task would be endless. For the same reason, it is not possible to take up each letter style and consider its use in stone and other materials. Of course, a Roman letter or any other similar form when drawn for stone-incised use must have its narrow lines at least twice as wide as when drawn in ink, black against a white background. (Compare Figs. 26 and 27.)

Experience and intuition combined with common sense will go farther than all the theory in the world to teach the limitations required by letter form and material. The student, however, should bear in mind that it is not necessary that he himself should make a number of mistakes in order to learn what *not* to do. He may get just as valuable information at a less cost by observing the mistakes and successes of others in actually executed work, and avail himself of their experience by applying it with intelligence to his own problems and requirements.



Fi.Fig 31 Black-Letter Alphabet ct.

GOTHIC LETTERING.

Gothic lettering is extremely difficult, and has little practical use for the architectural designer or draftsman. It is often appropriate, but it is quite possible to get along without employing this form at all. However, in case he should require a letter of this style, it would be better to refer him to some book where he may study its characteristics more particularly, remembering it is just as important he should know something of the history, uses and materials from which this letter has been taken, as in any instance of the use of the Roman form. Indeed, it might be

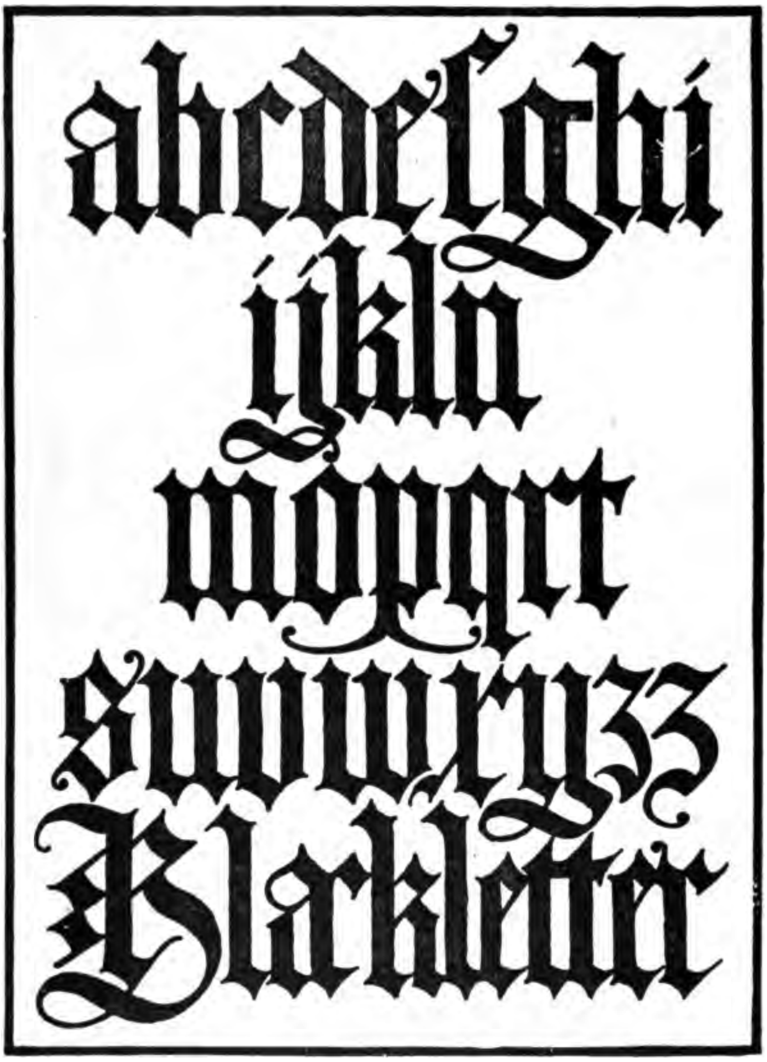


Fig. 35. Italian Black Letters after Bergomensis

said, it is even more important, as the Gothic letter is more universally misunderstood and misapplied than the simpler Roman letter.

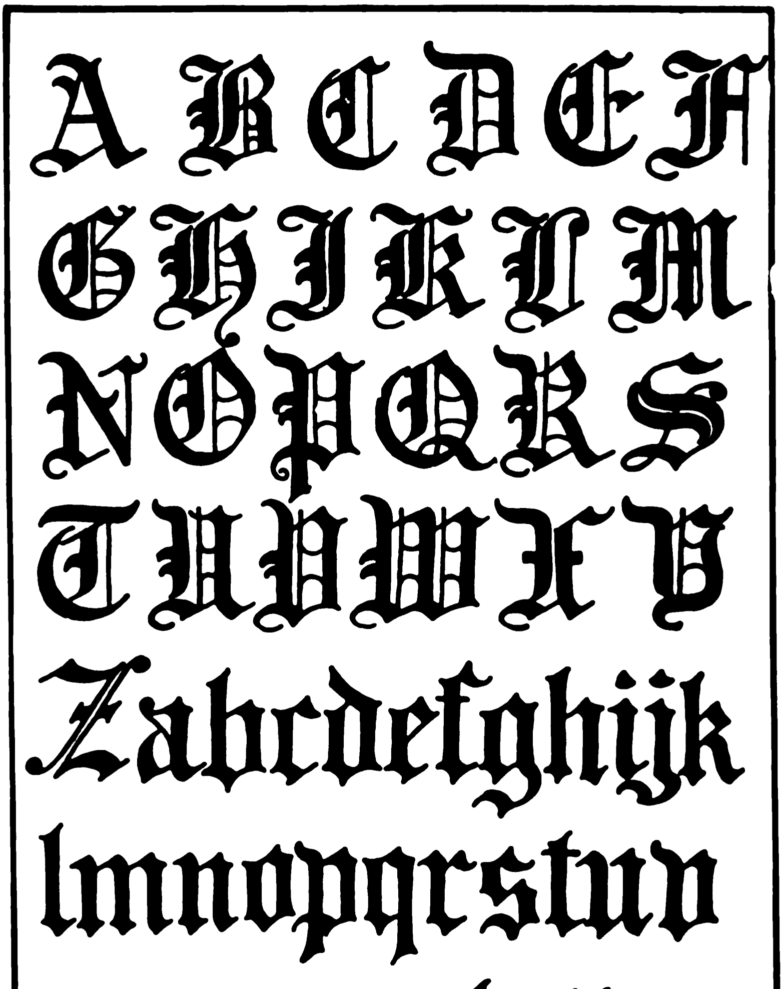


Fig. 36 English Gothic Text

The alphabet of German black letters shown in Fig. 35 is taken from a very beautiful example of Gothic black letter devised by Jacopus Phillipus Foresti (Bergomensis) and used by him in the title page of "De Claris Mulieribus," etc., published in Ferrara in 1497. Although Italian, this letter is as German in character as any of the examples from the pen of Albrecht Dürer. A German black letter redrawn from a brass is shown in Fig. 33, while an English form of Gothic letter is shown in Fig. 36.

In Fig. 34 is another example of a black-letter alphabet. The entire effect of a black-letter page depends upon the literal interpretation of the title "black letter." That is, the space of white between and among the letters should be overbalanced by the amount of black used in defining the letter form itself.

Inasmuch as this letter is likely to be used but little by architectural draftsmen, and as it is a much more difficult form to compose than even the Roman type, it seems better to refer the student to some treatise where its characteristics are taken up more thoroughly and at greater length.

Any draftsman having occasion to use lettering to any extent should have some fairly elaborate textbook always at hand for reference, and it is believed that "Letters and Lettering," a larger treatise published by the Bates and Guild Company of Boston, from which several of the illustrations reproduced in this pamphlet have been borrowed, contains more material in an easily available form than any other textbook on the subject.

EXAMINATION PLATES.

In addition to the following Examination Plates the student is expected to make careful reproductions of the lettering in the foregoing section.

PLATES I, II, III.

Draw the alphabet, using the same construction as given in Figs. 1 and 2, and making each letter two inches high. Put ten letters on each of the first two plates, and on the third arrange the remainder, including the two forms of W given in Fig. 2.

PLATE IV.

Make a careful reproduction of Fig. 10 on the left hand side of the plate. The letters should be of the same size as in Fig. 10. On the right-hand side of the plate use the letter forms shown in Fig. 10 and of the same size, and letter the following title, arranging the legend to look well on the plate: Front Elevation, Country House at Glen Ridge, New Jersey, Aug. 24, 1903. David Carlson Mead, Architect, No. 5925 State St., Chicago, Ill.

PLATE V.

Reproduce on this plate Figs. 27 and 32 of the Instruction Paper, using letters of the same size.

PLATE VI.

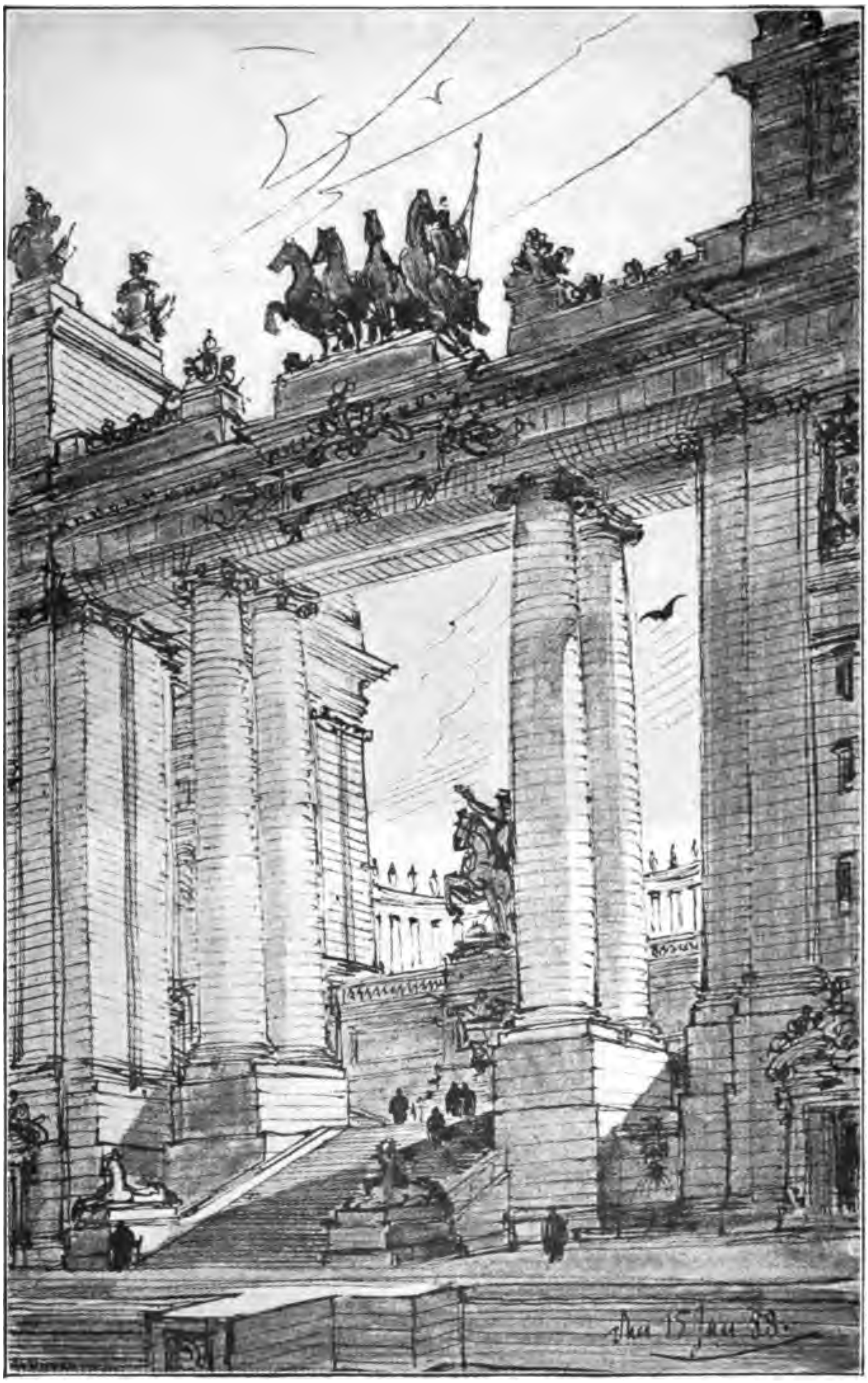
On the left hand side of this plate, copy the lettering shown in Fig. 9, making the letters at least as large as those in the illustration. On the right hand side, following the same style and size, letter the following title: Detail of Entrance Porch, Country House at Glen Ridge, New Jersey, Sept. 10, 1903. David Carlson Mead, Architect, No. 5925 State St., Chicago, Ill.

This [illegible]

PLATE VII.

[illegible] shown in Figs. 24 and [illegible]

[illegible]



EXAMPLE OF FREEHAND PEN-AND-INK RENDERING AND LIGHT WASHES
Composition and Drawing by Otto Rieth, Architect, Berlin, Germany
Reproduced from "Architekton Skizzen," Otto Rieth.

FREEHAND DRAWING.

1. The Value of Freehand Drawing to an Architect. Outside of its general educational value freehand drawing is as absolutely essential to the trained architect as it is to the professional painter. It is obviously necessary for the representation of all except the most geometric forms of ornament, and it is equally important in making any kind of a rapid sketch, either of a whole building or a detail, whether from nature or in the study of plans and elevations. It is perhaps not so generally understood that the training it gives in seeing and recording forms accurately, cultivates not only the feeling for relative proportions and shapes, but, also, that very important architectural faculty—the sense of the third dimension. The essential problem of most drawing is to express length, breadth, and thickness on a surface which has only length and breadth. As the architect works out on paper, which has only length and breadth, his designs for buildings which are to have length, breadth, and thickness, he is obliged to visualize; to see with the mind's eye the thickness of his forms. He must always keep in mind what the actual appearance will be. The study of freehand drawing from solid forms in teaching the representation on paper of their appearance, stimulates in the draughtsman his power of creating a mental vision of any solid. That is, drawing from solids educates that faculty by means of which an architect is able to imagine, before it is erected, the appearance of his building.

2. Definition of Drawing. A drawing is a statement of certain facts or truths by means of lines and tones. It is nothing more or less than an explanation. The best drawings are those in which the statement is most direct and simple; those in which the explanation is the clearest and the least confused by the introduction of irrelevant details.

A drawing never attempts to tell all the facts about the form depicted, and each person who makes a drawing selects not only the leading truths, but also includes those characteristics which appeal to him as an individual. The result is that no two people make drawings of the same subject exactly alike.

3. **The Eye and the Camera.** The question immediately arises: Why should we not draw all that we see; tell all that we know about our subject? Since the photograph does represent, with the exception of color, all that we see and even more, another question is raised: What is the essential difference between a photograph of an object and a drawing of an object? These are questions which bring us dangerously near the endless region of the philosophy of fine arts. Stated simply and broadly, art is a refuge invented by man as an escape from the innumerable and bewildering details of nature which weary the eye and mind when we attempt to grasp and comprehend them.

Without going into an explanation of the differences in structure between the lens of a camera and the lens of the eye, it may be accepted as a general statement that in spite of apparent errors of distortion the photograph gives us an exact reproduction of nature. Every minutest detail, every shadow of a shade, is presented as being of equal importance and interest, and it is easy to demonstrate that the camera sees much more detail than the human eye. In any good photograph of an interior the patterns on the walls and hangings, the carving and even the grain and texture of woods are all presented with equal clearness. In order to perceive any one of those details as clearly with the eye it would be necessary to focus the eye on that particular point, and while so focused all the other details of the room would appear blurred. The camera, on the contrary, while focused at one point sees all the others with almost equal clearness. This fact alone is enough to demonstrate the danger of assuming that the photograph is true to the facts of vision. Again, a photograph of an antique statue will exaggerate the importance of the weather stains and disfigurements at the expense of the subtle modelling of the muscular parts which the eye would instinctively perceive first.

Nature, then, and the photograph from nature, is a bewildering mass of detail. The artist is the man of trained perceptions who, by eliminating superfluous detail and grasping and presenting only the essential characteristics, produces a drawing in which we see the object in a simplified but nevertheless beautiful form.

In looking at the drawing we become conscious of the subject and its principal attributes; we comprehend and realize these with far less effort of the mind and eye than we should expend in taking in and comprehending the real object or a photograph of it. Compared to nature it is more restful and more easily understood, and the ease with which it is comprehended constitutes, the psychologists say, a large part of the pleasure we take in art; it certainly explains why we enjoy a drawing of an object when we may take no pleasure in the object itself, or a photograph of it.

4. **Restraint in Drawing.** The practical application of the preceding broad definition is neither difficult nor abstruse. The beginner in drawing usually finds his work swamped in a mass of detail, because his desire is to be absolutely truthful and accurate, and the more he has read Ruskin* and writers of his school the more does he feel that art and nature are one, and that the best drawing is that which most successfully reproduces nature with photographic fidelity. It may be taken for granted that a drawing must be true; true to nature. But truth is at best a relative term, and while it may be said that every normal eye sees practically the same, yet, after all, the eye sees only what it is trained to see. It is the purpose of all teaching of drawing to train the eye to see and the hand to put down the biggest and most important truths and to sacrifice small and unimportant details for the sake of giving greater emphasis or accent to the statement of the larger ones. "Art lives by sacrifices" is the expression of the French, the most artistic nation of modern times. The experience of the beginner is very practical testimony to the truth of the expression, for he very soon realizes that he has not the ability, even if it were best, to draw all he sees, and he has to face the question of what to leave out, what to sacrifice. Sense will tell him that he must at all costs retain those elements which have the most meaning or significance, or else his drawing will not be intelligible. So he is gradually taught to select the vital facts and make sure of them at least. It is true that the more accomplished the draughtsman becomes the greater will be his ability to successfully represent the lesser truths, the smaller details he sees,

---

*NOTE.—Ample corroboration for all that is stated above may be found in Ruskin, but it is embedded in a mass of confusing and contradictory assertions. Ruskin is a very dangerous author for the beginner.

because having trained his perception to the importance of grasping the big truths he has also attained the knowledge and ability to express the smaller facts without obscuring the greater ones. Nevertheless the question of what to sacrifice remains one of the most important in all forms of representation. One of the commonest criticisms pronounced by artists on the work of their colleagues is that "he has not known when to stop"; the picture is overloaded and obscured with distracting detail.

5. **Learning to See.** It is very important that the student of drawing shall understand in the beginning that a very large part of his education consists in learning to see correctly. The power to see correctly and the manual skill to put down with accuracy what he sees—these he must acquire simultaneously. It is usually difficult at first to convince people that they do not naturally and without training see correctly. It is true that there is formed in every normal eye the same image of an object if it is seen from the same position, but as minds differ in capacity and training, so will they perceive differently whatever is thrown upon the retina or mirror of the eye.

It is a matter of common observation that no two people agree in their description of an object, and where events are taking place rapidly in front of the eyes, as in a football game, one person with what we call quick perceptions, will see much more than another whose mind works more slowly; yet the same images were formed in the eyes of each. The person who understands the game sees infinitely more of its workings than one who does not, because he **knows what to look for;** and to draw with skill one must also know what to look for. Many people who have not studied drawing say they see the top of a circular table as a perfect circle in whatever position the eye may be in regard to the table. Others see a white water lily as pure white in color, whether it is in the subdued light of an interior or in full sunlight out of doors. In questions of color it is a matter of much study, even with persons of artistic gifts and training, to see that objects of one color appear under certain conditions to be quite a different color.

6. **Outline.** The untrained eye usually sees objects in outline filled in with their local color, that is, the color they appear to be when examined near the eye without strong light or shade

thrown upon them. One of the first things the student has to learn is that there are no outlines in nature. Objects are distinguished from each other not by outlines but by planes of light and dark and color. Occasionally a plane of dark will be so narrow that it can only be represented by a line, but that does not refute the statement that outlines do not exist in nature. Very often only one part of an object will be detached from its surroundings. Some of its masses of light may fuse with the light parts of other forms or its shadows with surrounding shadows. If enough of the form is revealed to identify it, the eye unconsciously supplies the shapes which are not seen, and is satisfied. The beginner in drawing is usually not satisfied to represent it so, but draws definitely forms which he does not see simply because he knows they are there. Obviously then it is necessary to learn what we do not see as well as what we do.

7. Although there are no outlines in nature, most planes of light and shade have definite shapes which serve to explain the form of objects and these shapes all have contours, edges or boundaries where one tone stops and another begins. As the history of drawing shows, it has always been a convention of early and primitive races to represent these contours of objects by lines, omitting effects of light and shade. To most people to-day the outline of an object is its most important element—that by which it is most easily identified—and for a large class of explanatory drawings outlines without light and shade are sufficient. By varying the width and the tone of the outline it is even possible to suggest the solidity of forms and something of the play of light and shade and of texture.

8. Since, in order to represent light and shade, it is necessary to set off definite boundaries or areas and give them their proper size and contour, it follows that the study of outline may very well be considered a simple way of learning to draw, and a drawing in outline as one step in the production of the fully developed work in light and shade. An outline drawing is the simplest one which can be made, and by eliminating all questions of light and shade the student can concentrate all his effort on representing contours and proportions correctly. But he should always bear in mind that his drawing is a convention, that it is not as he actually

sees nature, and that it can but imperfectly convey impressions of the surfaces, quality and textures of objects.

9. It is often asserted that whoever can learn to write can learn to draw, but one may go further and assert that writing is drawing. Every letter in a written word is a drawing from memory of that letter. So that it may be assumed that every one who can write already knows something of drawing in outline, which is one reason why instruction in drawing may logically begin with the study of outline.

Some good teachers advocate the immediate study of light and shade, arguing that since objects in nature are not bounded by lines to represent them so it is not only false but teaches the student to see in lines instead of thinking of the solidity of objects. But these arguments are not sufficient to overbalance those in favor of beginning with outline, especially in a course planned for architectural students to whom expression in outline is of the first importance.

MATERIALS.

10. Pencils. Drawings may be made in "black and white" or in color. A black and white drawing is one in which there is no color and is made by using pencil, charcoal, crayon or paint which produces different tones of gray ranging from black to white.

The pencil is the natural medium of the architect and the materials for pencil drawing are very inexpensive and require little time for their preparation and care. Drawings in pencil are very easily changed and corrected if necessary. All the required plates for this course are to be executed in pencil.

The pencil will make a drawing with any degree of finish ranging from a rough outline sketch to the representation of all the light and shade of a complicated subject. In addition it is the easiest of all mediums to handle. Students are sometimes led to think that it is more artistic to draw in charcoal crayon or pen and ink. It may be that an additional interest is aroused in some students by working in these materials, but the beginner must assure himself at once that artistic merit lies wholly in the result and not at all in the material in which the work is executed.

Pencils are made in varying degrees of hardness. The softest

is marked BBBBBB or 6B; 5B is slightly less soft and they increase in hardness through the following grades: 4B, 3B, 2B, B, HB, F, H, 2H, 3H, 4H, 5H, 6H. A pencil should mark smoothly and be entirely free from grit. The presence of grit is easily recognized by the scratching of the pencil on the paper and by the unevenness in the width and tone of the line. The leads of the softer pencils are the weaker and are more easily broken. They give off their color the most freely and produce blackest lines. What hardness of pencils one should use depends upon a number of considerations, one of the most important being the quality of paper upon which the drawing is made.

Quick effects of light and shade can be best produced by the use of soft pencils because they give off the color so freely and the strokes blend so easily into flat tones.

A medium or hard pencil is necessary when a drawing is to be small in size and is intended to express details of form and construction rather than masses of light and shade. This is because the lines made by hard pencils are finer, and more clean and crisp than can be obtained by using soft grades. The smaller the drawing, the more expression of detail desired, the harder the pencil should be; a good general rule for all quick studies of effects of light and shade is to use as soft a pencil as is consistent with the size of the drawing and the surface of the paper. Beginners, however, are obliged to make many trial lines to obtain correct proportions, and in that way produce construction lines so heavy that the eraser required to remove them leaves the paper in a damaged condition. Until the student can draw fairly well he should begin every piece of work with a medium pencil and take care to make very light lines and especially to avoid indenting the paper.

It should be understood that pencil drawings ought never to be very large. There should always be a proportional relation between the size of a drawing and the medium which produces it. The point of a pencil is so small that to make a large drawing with it consumes a disproportionate amount of time. For large drawings, especially such showing light and shade, crayon or charcoal are the proper materials for they can be made to cover a large surface in a very short time. The larger the area to be covered the larger should be the point and the line producing it.

Special pencils with large leads can be obtained for making large pencil drawings.

11. Paper. In general the firmer the surface of the paper the harder the pencil one can use on it. For a medium or hard pencil the paper should be tough and rather smooth but never glazed. Many very cheap grades of paper, for example that on which newspapers are printed, take the pencil very well but have not a sufficiently tough surface to allow the use of the eraser. They are excellent for rapid sketches made very directly without alterations.

Paper for effects of light and shade should be soft and smooth. For this work the cheaper grades of paper are often more suitable than the expensive sorts. Paper with a rough surface should always be avoided in pencil drawings, as it gives a disagreeable "wooly" texture to the lines.

12. Holding the Pencil. Any hard and fast rules for the proper use of the pencil would be out of place; but until the student has worked out for himself the ways which are the easiest and best for him he cannot do better than adopt the following suggestions, which will certainly aid him in using the pencil with effect and dexterity.

The most important points in drawing are to be accurate and at the same time direct and free. Of course, accuracy—the ability to set down things in their right proportions—is indispensable; but the abilty to do this in the most straightforward way without constraint, fumbling, and erasures is also necessary. Art has been defined as the doing of any one thing supremely well.

The pencil should be held lightly between the thumb and forefinger three or four inches from the point, supported by the middle finger, with hand turned somewhat on its side.

There are three ways in which it is possible to move the pencil; with the fingers, the wrist, or the arm. Most people find it convenient to use the finger movement for drawing short, vertical lines. In order to produce a long line by this movement it is only necessary to make a succession of short lines with the ends touching each other but not overlapping, or by leaving the smallest possible space between the end of one line and the beginning of the next. The wrist movement produces a longer line and is used naturally to make horizontal lines. For a very long sweep of line the movement of the arm from the shoulder is necessary. This is, perhaps, the most difficult way of drawing for the beginner, but it affords the greatest freedom and sweep, and many teachers consider it the only proper method.

13. **Position.** The draughtsman should sit upright and not bend over his drawing, as that cramps the work and leads him to look, while working, at only a small portion of his drawing instead of comprehending the whole at a glance.

The surface to receive the drawing must be held at right angles to the direction in which it is seen, otherwise the drawing will be distorted by the foreshortening of the surface. A rectangular surface such as a sheet of paper is at right angles to the direction in which it is seen when all four corners are equally distant from the eye. A fairly accurate test may be made in the following manner: Locate the center of the paper by drawing the diagonals. Flat against this point place the unsharpened end of a pencil. Tip the surface until the length of the pencil disappears and only the point and sharpened end are visible, then the surface will be at right angles to a line drawn from the eye to its center. The pencil represents this line for a part of the distance because if properly held it is at right angles to the surface.

FIRST EXERCISES.

Before trying to draw any definite forms the student should practice diligently drawing straight lines in horizontal, vertical, and oblique positions, and also circles and ellipses.

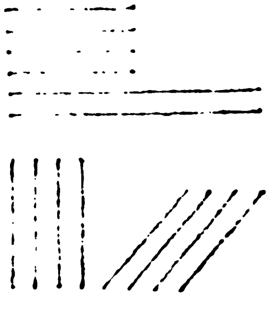


Fig. 1. Lines Connecting Points

14. **Straight Lines.** In drawing the straight line exercises points should first be placed lightly and the line drawn to connect them as in Fig. 1. Draw a series of ten or fifteen lines in each position, placing the points to be connected by the lines one inch apart and leaving a space of one quarter of an inch between each line. Next draw a series placing the points two inches apart, then a group with the points four inches apart, and finally a set which

will give lines eight inches long. Start to draw vertical lines from the top, horizontal lines from the left to right, oblique lines which slant upward toward the right, from the lower point, and those slanting upward toward the left, from the upper point. Use all three pencils, 3H, F and a solid ink pencil for these exercises, and take the greatest care not to press too strongly on the paper with the harder grades. They are intended to make rather light gray lines. Where dark lines are desired always use the solid ink pencil. Try also making the exercises with different widths of line regulated by the bluntness of the point, and do at least one set using the solid ink pencil and making very wide lines as near together as is possible without fusing one line with another. In all of these exercises the lines should each be drawn with one pencil stroke without lifting the pencil from the paper and absolutely no corrections of the line should be made.

15. Circles and Ellipses. In practicing drawing circles start from a point at the left and move around toward the right as in Fig. 2. Draw a series of ten circles half an inch in diameter, forming each with a single pencil stroke. Next draw a group of ten with a one-inch diameter, still keeping to the single pencil stroke. Follow these with a set, each being two inches in diameter and another set with a three-inch diameter. In drawing these larger circles the free arm movement will be found necessary and the lines may be swept about a number of times for the purpose of correcting the first outline and giving practice in the arm movement. As the circles increase in diameter the difficulty of drawing them with accuracy by a single stroke increases also, but instead of erasing the faulty positions and laboriously patching the line, it is better to make the corrections as directed, by sweeping other lines about until a mass of lines is formed which gives the shape correctly. The single outline desired will be found somewhere within the mass of lines and may be accented with a darker line and the other trial lines erased.

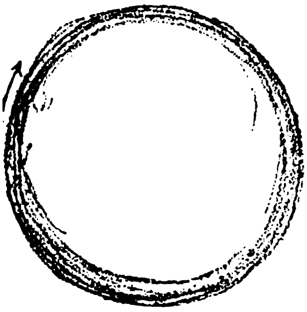


Fig. 2. Circles.

Draw a series of ten ellipses, Fig. 3, with a long diameter of half an inch, forming each with a single pencil stroke. Follow with a group of ten, having the long diameter one inch in length, joining each outline with a single pencil stroke. Proceed with a set having a long diameter of two inches and a set with a long diameter of three inches. Follow the same instructions for these last two groups as were laid down for drawing the larger circles, that is, sweep the lines about several times with the free arm movement.

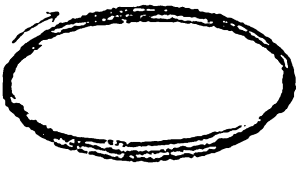


Fig. 3 Ellipses.

In drawing horizontal straight lines the elbow should be held close to the body. For vertical lines and for all curved lines the elbow should be held as far from the body as possible.

These exercises and similar ones of his own invention should be practiced by the student for a long period, even after he is studying more advanced work. Any piece of waste paper and any spare moments may be utilized for them. As in acquiring any form of manual skill, to learn to draw requires incessant practice, and these exercises correspond to the five-finger exercises which are such an important part of the training in instrumental music. While they are not very interesting in themselves the training they give to the muscles of the hand and arm is what enables the draughtsman to execute his work with rapidity, ease, and assurance.

The student should bear in mind that a straight freehand line ought not to look like a ruled line. A part of the attraction of freehand drawing, even of the simplest description, is the sensitive, live quality of the line. A straight line is defined in geometry as one whose direction is the same throughout, but slight deviations in a freehand straight line, which recover themselves and do not interfere with the general direction are legitimate, as the hand, even when highly trained, is not a machine, and logically should not attempt to do what can be performed with more mechanical perfection by instruments. Where freehand straight lines are used to indicate the boundaries of forms, the slight inevitable variations in the line are really more true to the facts of vision than a ruled line would be, inasmuch as the edges even of geometric solids appear softened and less rigid because they are affected by the play of light and by the intervening atmosphere.

This the beginner will not be able to see at first, for in this case as in so many others, his sight is biased by his knowledge of what the object is and how it feels.

16. Freehand Perspective. One of the chief difficulties in learning to draw is, as before stated, in learning to see correctly, because the appearance of objects so often contradicts what we know to be true of them. More than one beginner has drawn a handle on a mug because he knew it was there, regardless of the fact that the mug was turned in such a way that the handle was not visible. The changes which take place in the appearance of forms through changes in the position from which they are seen, are governed by the principles of perspective. Although students of this course are supposed to be familiar with the science of perspective, it is necessary to restate certain general principles of perspective with which the freehand draughtsman must be so familiar that he can apply them almost unconsciously as he draws. The most important of these are demonstrated in the following paragraphs, and their application should be so thoroughly understood that they become a part of the student's mental equipment. In theory the draughtsman draws what he sees, but practically he is guided by his knowledge as to how he sees.

The principles can be most clearly demonstrated through the study of certain typical geometric forms which are purposely stripped of all intellectual or sentimental interest, so that nothing shall divert the attention from the principles involved in their representation. The student will readily recognize the great variety of subjects to which the principles apply and the importance of working out the exercises and mastering them for the sake of the knowledge they impart. These principles can be explained very clearly by the use of the glass slate, which is a part of the required outfit for this course. All drawings should be made from the models in outline and in freehand on the glass, using the Cross pencil. The drawing should be tested and corrected according to the instructions for testing.

17. Tracing on the Slate. In beginning to study model drawing the model may be traced upon the slate held between the model and the eye and at right angles to the direction in which the object is seen. (See section 13.) In order to do this with accuracy it is absolutely necessary that the slate shall not move and it is equally necessary that the position of the eye shall not change. As neither of these conditions can be fulfilled exactly without mechanical contrivances for holding both the slate and the head fixed, it follows that the best tracing one can make will be only approximately correct and even that only if the object is of a very simple character. The more complicated the object the less satisfactory will be the tracing from it. Perhaps the best method is to mark the important angles and changes of direction in the contour with points and then rapidly connect the points with lines following the contours. Although the result may not be very correct, if carefully made the tracing will at least demonstrate the principal points wherein the appearance of an object differs from and contradicts the facts, and that is the sole object of the tracing. It awakens in the student the power of seeing accurately as it teaches the mind to accept the image in the eye as the true appearance of an object even if that image differs from the actual shape and proportion of the object as we know it by the sense of touch. *Except as it helps us to learn to see, the tracing gives no training in freehand drawing other than the slight manual exercise involved in drawing the line.*

18. Testing with the Slate. The great value of the slate for the beginner in freehand drawing is the ease with which the accuracy of a drawing may be tested. To obtain satisfactory results the models should be placed about a foot and a half in front of the spectator and the drawings made rather large. The drawing should be made freehand, in outline, and the greatest care taken to make it as accurate as possible before testing it because the object in making the drawing is to exercise the hand and eye. Drawing exercises should not be confounded with the preliminary exercises in tracing whose only object is to emphasize the fact that forms appear different as the position of the eye changes.

In order to test a drawing place the slate at right angles to a line from the eye to the model according to the directions in section 13. Holding the slate at this angle and keeping one eye closed move it backward and forward until the lines of the drawing cover the lines of the model. Any difference in the general direction of the lines or proportions can be readily observed. Corrections should not be made by tracing, but errors should be carefully noted and the alterations made freehand from a re-study of the models. If the drawing is too large to cover the lines of the model, errors may be discovered by testing the different angles of the drawing with those of the model. If all the angles coincide the drawing must be correct.

In making the tests the slate should be held firmly with both hands, and it cannot be emphasized too strongly that the test is of no value unless the slate is at right angles to the direction in which the model is seen. When groups of models or other complicated subjects are being tested only the directions of important lines and proportions of leading masses can be compared. It must be clearly understood that it takes some practice and much care to test the drawing of a simple form, and that the slate is not to be used as a means of tracing. The student will soon discover that it is impossible to trace any form or group having much detail or multiplication of parts owing to the impossibility of holding the slate and the eye for long in the same position at the same time.

Do not expect too much of the slate. Even the first exercises in tracing simple forms will show the student that unless he has acquired some facility in making lines freehand he cannot trace lines. Indeed it has often been observed that no one can trace who cannot draw. Another difficulty in using the slate at first is the resistance which the pencil encounters on the glass. It calls for a different pressure and touch from that used with a pencil on paper, so that the beginner is often discouraged unnecessarily and becomes impatient with the slate, partly because he expects too much from it and partly because he has not learned how to use it. Do not try to make perfect lines on the slate. Be satisfied at first to indicate the general direction of lines. Understand also that the slate is only to be used in beginning to draw. The student should as soon as possible emancipate himself from the use of the tests and depend upon the eye alone for judging the relations of proportions and lines. From the beginning a drawing should be corrected by the eye as far as possible before applying any tests.

FREEHAND PERSPECTIVE.*

19. The Horizon Line or Eye Level. This, as the name implies, is an imaginary horizontal line on a level with the eye. It is of great importance in representation, as all objects appear to change their shape as they are seen above or below the horizon line.

The following experiments should be made before beginning to draw any of the exercises in freehand perspective. Fasten two square tablets together at right angles to each other so that the adjacent corners exactly coincide, giving two sides of a cube. Hold it at arm's length with the edge where the two planes touch, parallel to the eyes and the upper plane level. Lower it as far as the arms allow, then raise it gradually to the height of the eyes, and above as far as possible, holding it as far out as possible. Observe that the level tablet appears to become narrower as it approaches the eye level, and when it is opposite the eye it becomes only a line showing the thickness of the cardboard. Observe that this line or front edge of the tablet always appears its actual length while the side edges have been gradually appearing to become shorter. As the tablet is lifted above the horizon the lower side begins to appear very narrow at first, but widening gradually the higher the tablet is lifted. It will be seen also that when the tablet is below the horizon line the side edges appear to run upward, and when the tablet is above the eye its side edges appear to run downward, toward the horizon.

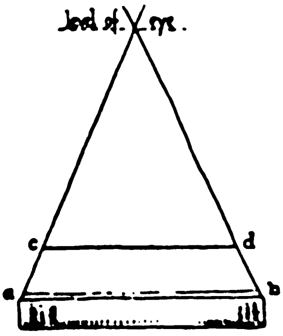


Fig 4. Book with Strings.

That they and similar lines appear to converge and vanish in the horizon line is proved by the following experiment:

Place a book on a table about two feet away with its bound edge toward the spectator and exactly horizontal to the eye, that is, with either end equally distant from the eye. Between the cover and the first page and as near the back as possible place a string, leaving about two feet of it on either side. Hold the left end of the string in the right hand and move it until it coincides with or covers the left edge of the book. Hold the right end of the string in the left hand and move it until it covers the right edge of the book. The two strings will be seen to form two converging or vanishing lines which meet at a point on the level of the eye, that is, in the horizon line. This and the preceding experiment illustrate the following rule:

---

*NOTE. Through the courtesy of its author and publishers, these exercises in freehand perspective have been adopted from the text-book on "Freehand Drawing," by Anson K. Cross. Ginn & Co., Boston.

Rule 1. Horizontal retreating lines above the eye appear to descend or vanish downward, and horizontal retreating lines below the eye appear to ascend or vanish upward. The vanishing point of any set of parallel, retreating, horizontal lines is at the level of the eye.

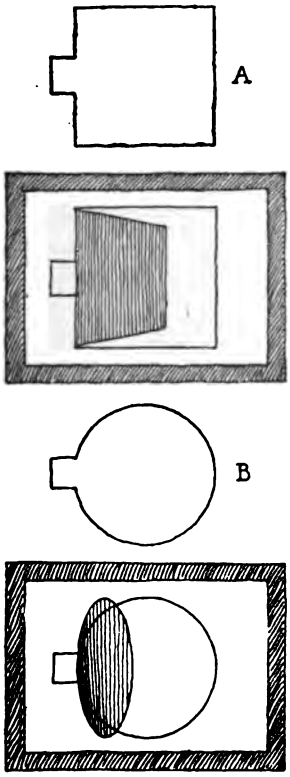


Fig. 5. Slates with Square and Circle Flaps.

It is necessary to remember that the horizon line is changed when the spectator's position is changed. This is very noticeable when one stands on a high hill and observes that the roof lines of houses which one is accustomed to see vanishing downward to the level of the eye, now vanish upward, since the eyes have been raised above the roofs.

Retreating lines are those which have one end nearer the eye than the other.

Exercise 1. Foreshortened Planes and Lines. Cut from paper a tracing of the square tablet, which is a part of the set of drawing models, and leave a projecting flap as at A, Fig. 5. Paste the flap on the under side of the slate, with the edges of the square parallel to the edges of the slate, and trace the actual shape of the square.

Holding the slate vertical and so that half the square is above and half below the level of the eye, turn the square somewhat away from the slate and trace the appearance. Turn it still farther and trace. Turn it so that the surface disappears and becomes a line.

Trace a circular tablet and cut it out of paper, leaving a flap as at B, Fig. 5. Paste the flap on the back of the slate, as with the square, and trace its real appearance. Turn the circle away at a moderate angle and trace its appearance. Trace it as it appears at a greater angle and finally place it so that it appears as a line.

Try similar experiments with the triangle, the pentagon, and the hexagon and observe that these exercises all show that lines and surfaces under certain conditions appear less than their true dimensions, and that this diminution takes place as soon as the surfaces are turned away from the glass slate.

When the square rests against the slate, with the centers of the square and slate coinciding, and the slate held so that half is above and half below the horizon line, all four corners of the square will be at equal distances from the eye so that a line from the eye to the center of the slate and of the square is at right angles to the surface of the slate, the latter represents in these experiments what in scientific perspective is called the picture plane. Thus a surface or plane appears its true relative dimensions only when it is at right angles to the direction in which it is seen.

It is for this reason that it is always necessary to arrange the surface on which a drawing is made, at right angles to the eye, otherwise the surface and drawing upon it become foreshortened; that is, they appear less than their true dimensions.

It is easy to see from the drawing of the foreshortened square in Fig. 4, that of the two equal and parallel lines *a b* and *c d* the nearer appears the longer, although neither of the lines are foreshortened as the respective ends of each are equally distant from the eye. This illustrates the following rule:

Rule 2. Of two equal and parallel lines, the nearer appears the longer.

Exercise 2. The Horizontal Circle. Hold the circular tablet horizontally and at the level of the eye. Observe that it appears a straight line.

Place the tablet horizontally on a pile of books about half way between the level of the eye and the level of the table. Trace the appearance upon the slate.

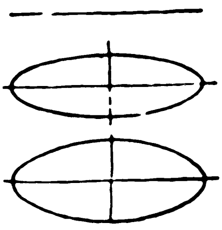


Fig. 6. Horizontal Circles.

Place the tablet on the table and trace its appearance.

While making both tracings the distance between the eye and the object, and the eye and the slate should be the same.

Hold the tablet at different heights above the level of the eye and observe that the ellipse widens as the height above the eye increases. These exercises illustrate the following rules:

Rule 3. A horizontal circle appears a horizontal straight line when it is at a level of the eye. When below or above this level the horizontal circle always appears an ellipse whose long axis is a horizontal line.

Rule 4. As the distance above or below the level of the eye increases the ellipse appears to widen. The short axis of any ellipse which represents a horizontal circle changes its length as the circle is raised or lowered. The long axis is always represented by practically the same length at whatever level the circle is seen.

Place the tablet on the table almost directly below the eye and trace its appearance.

Move it back to the farther edge of the table and trace it. It will be seen that where the level of the circle remains the same, its apparent width changes with the distance from the eye to the circle.

Exercise 3. Parallel Lines. Place the square tablet on the table 1½ feet from the front, so that its nearest edge appears horizontal; that is, so that it is at right angles to the direction in which it is seen. By tracing the appearance the following rules are illustrated:

Fig. 7. Parallel Lines.

Rule 5. Parallel retreating edges appear to vanish, that is, to converge toward a point.

Rule 6. Parallel edges which are parallel to the slate, that is, at right angles to the direction at which they are seen, do not appear to converge, and any parallel edges whose ends are equally distant from the eye appear actually parallel.

Exercise 4. The Square. Place the square tablet as in Exercise 3, and it will be seen that two of the edges are not foreshortened but are represented by parallel horizontal lines. The others vanish at a point over the tablet on a level with the eye.

Now place the tablet so that its edges are not parallel to those of the desk and trace its appearance on the slate. None of its edges appear horizontal, and when the lines of the tracing are continued as far as the slate will allow, the fact that they all converge will be readily seen; the drawing illustrates the following rule:

Rule 7. When one line of a right angle vanishes toward the right, the other line vanishes toward the left.

The drawing also shows that the edges appear of unequal length and make unequal angles with a horizontal line and illustrates the following rule:

Rule 8. When two sides of a square retreat at unequal angles, the one which is more nearly parallel to the picture plane (the slate) appears the longer and more nearly horizontal.

Exercise 5. The Appearance of Equal Spaces on Any Line. Cut from paper a square of three inches and draw its diagonals. Place this square horizontally in the middle of the back of the table, with its edges parallel to those of the table, and then trace its appearance and its diagonals upon the slate. (Fig. 8.)

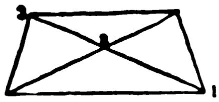


Fig. 8. Equal Space on any Line.

Note. - The diagonals of a square bisect each other and give the center of the square.

Compare the distance from the nearer end, 1, of either diagonal to the center of the square, 2, with that from the center of the square to the farther end of the diagonal, 3, for an illustration of the following rule:

Rule 9. Equal distances on any retreating line appear unequal, the nearer of any two appearing the longer.

Exercise 6. The Triangle. Draw upon an equilateral triangular tablet a line from an angle to the center of the opposite side. (This line is called an altitude.)

Connect the triangular tablet with the square tablet, and place them on the table so that the base of the triangle is foreshortened, and its altitude is vertical. Trace the triangle and its altitude upon the slate. The tracing illustrates the fact that the nearer half of a receding line appears longer than the farther half (see Rule 9), and also the following rule:

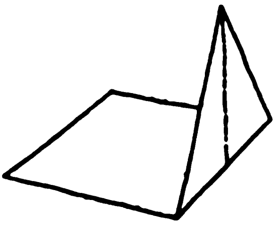


Fig. 9. The Triangle.

Rule 10. The upper angle of a vertical isosceles or equilateral triangle, whose base is horizontal, appears *in a vertical line erected at the perspective center of the base.*

Exercise 7. The Prism. Connect two square tablets by a rod to represent a cube, and hold the object so that one tablet only is visible, and discover that it must appear its real shape, A, Fig. 10. This illustrates the following rule:

Rule 11. When one face only of a prism is visible, it appears its real shape.

Place the cube represented by tablets (Fig. 10) in the middle of the back of the desk, and trace its appearance. First, when two faces only of the solid would be visible (B); and, second, when three faces would be seen (C). These tracings illustrate the following rule:

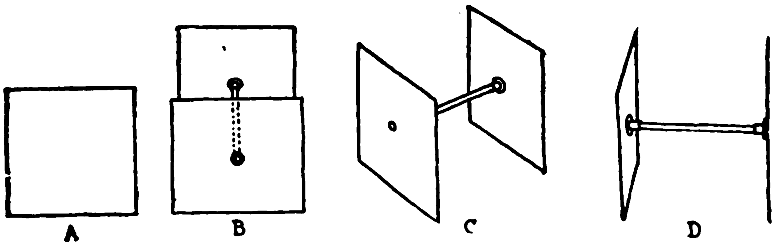


Fig. 10. The Prism.

Rule 12. When two or more faces of a cube are seen, none of them can appear their real shapes.

Place the cubical form on the desk, with the tablets vertical, and one of them seen edgewise (D) and discover that the other tablet does not appear a straight line. This illustrates the following rule:

Rule 13. Only one end of a prism can appear a straight line at any one time.

Exercise 8. The Cylinder. Connect two circular tablets by a $2\frac{1}{2}$-inch stick, to represent the cylinder. Hold the object so that one end only is visible, and see that it appears a circle (Fig. 11).

Place the object on the table, so that its axis is horizontal but appears a vertical line, and trace its appearance. The tracing illustrates the following rule:

Rule 14. When an end and the curved surface of a cylinder are seen at the same time, the end must appear an ellipse (Fig. 12).

Place the object horizontally, and so that one end appears a vertical line, and trace to illustrate the following rule:

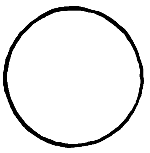


Fig. 11. The Cylinder—Circle.

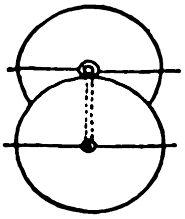


Fig. 12. The Cylinder—Axis Horizontal.

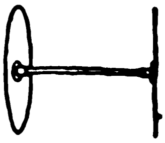


Fig. 13. The Cylinder—One End Straight Line.

Rule 15. When one end of a cylinder appears a straight line, the other appears an ellipse. (*Fig. 13.*)

Place the object upright on the table, and trace its ends and axis. Draw the long diameters of the ellipse, and discover that they are at right angles to the axis of the cylinder. This illustrates the following rule:

Rule 16. The bases of a vertical cylinder appear horizontal ellipses. The nearer base always appears the narrower ellipse. (*Fig. 14.*)

Place the object with its axis horizontal and at an angle, so that the surfaces of both tablets are visible. Trace the tablets and the rod, and then draw the long diameters of the ellipses, and discover that they are at right angles to the axis of the cylindrical form. The axes of the ellipses are inclined, and the drawing illustrates the following rules:

Rule 17. The bases of a cylinder appear ellipses, whose long diameters are at right angles to the axis of the cylinder, the nearer base appearing the narrower ellipse.

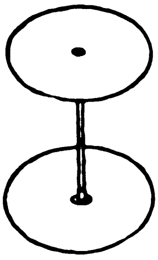


Fig. 14. The Cylinder - Upright.

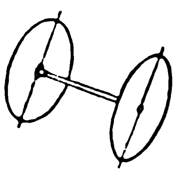


Fig. 15. The Cylinder Axis Horizontal and at an Angle.

Note. The farther end may appear narrower than the nearer, but must always appear proportionally a wider ellipse than the nearer end.

Rule 18. Vertical foreshortened circles below or above the level of the eye appear ellipses whose axes are not vertical lines.

Rule 19. The long axis of an ellipse representing a vertical circle below or above the level of the eye is at right angles to the axis of a cylinder of which the circle is an end.

Rule 20. The elements of the cylinder appear to converge in the direction of the invisible end. This convergence is not represented when the cylinder is vertical.

Note 1.—Less than half the curved surface of the cylinder is visible at any one time.

Note 2.—The elements of the cylinder appear tangent to the bases and must always be represented by straight lines tangent to the ellipses which represent the bases. When the elements converge, the tangent points are not in the long axes of the ellipses. See Fig. 12, in which if a straight line tangent to the ellipse be drawn, the tangent points will be found above the long axes of the ellipses.

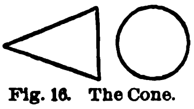


Fig. 16. The Cone.

Exercise 9. The Cone. Hold the cone so that its axis is directed toward the eye, and the cone appears a circle. Hold the cone so that its base appears a straight line, and it appears a triangle. (Fig. 16.)

Place a circular tablet, Fig. 17, having a rod attached, to represent the axis of the cone, so that the axis is first vertical and second inclined. Trace both positions of the object, and discover that the appearance of the circle is the same as in the case of the cylinder. The tracings illustrate the following rule:

Rule 21. When the base of the cone appears an ellipse, the long axis of the ellipse is perpendicular to the axis of the cone.

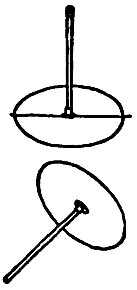


Fig. 17. The Cone—Tablet with Rod.

Note 1.—More than half the curved surface of the cone will be seen when the vertex is nearer the eye than the base, and less than half will be seen when the base is nearer the eye than the vertex. The visible curved surface of the cone may range from all to none.

Note 2.—The contour elements of the cone are represented by straight lines tangent to the ellipse which represents the base, and the points of tangency are not in the long axis of this ellipse.

ART PANELS IN CITY HALL, CHICAGO
Upper Left, Public Schools; Upper Right, Playgrounds;
Lower Left, Public Parks; Lower Right, Water Works System

Exercise 10. The Regular Hexagon. In Fig. 18 the opposite sides are parallel and equal. The long diagonal A D is parallel to the sides B C and E F, and it is divided into four equal parts by the short diagonals B F and C E, and by the long diagonals B E or C F.

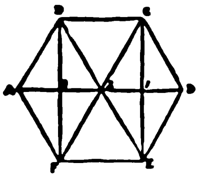


Fig. 18. Hexagon.

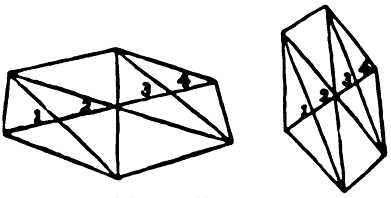


Fig. 19. Hexagon.

The perspective drawing of this figure will be corrected by giving the proper vanishing to the different sets of parallel lines, and by making the divisions on the diagonal A D perspectively equal.

Draw the long and short diagonals upon a large hexagonal tablet. Place this tablet in a horizontal or vertical position, Fig. 19, and then trace upon the slate its appearance and the lines upon it. The tracing illustrates the following rule:

Rule 22. In a correct drawing of the regular hexagon, any long diagonal when intersected by a long diagonal and two short diagonals, will be divided into four equal parts.

Exercise 11. The Center of the Ellipse Does Not Represent the Center of the Circle. Cut from paper a square of three inches, after having inscribed a circle in the square. Draw the diameters of the square and then place the square horizontally at the middle of the back of the table, with its edges parallel to those of the table. Trace the square, its diameters, and the inscribed circle, upon the slate. The circle appears an ellipse, and as the long axis of an ellipse bisects the short, it is evident that it must come below the

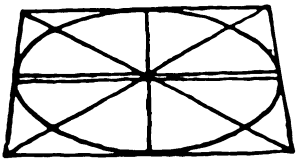


Fig. 20 Center of Circle not Center of Ellipse.

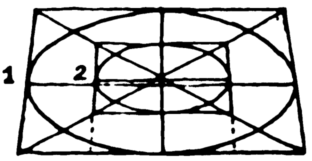


Fig. 21. Concentric Circles.

center of the square, and we discover that the center of the ellipse does not represent the center of the circle, and that the diameter of the circle appears shorter than a chord of the circle.

Exercise 12. Concentric Circles. Cut a 4-inch square from practice paper, and draw the diagonals. With the center of the square as center draw two concentric circles, 4 inches and 2 inches in diameter.

Place the card horizontally upon the table, as illustrated, and trace its appearance upon the slate, together with all the lines drawn upon it.

Draw the vertical line which is the short axis of both ellipses. Bisect the short axis of the outer ellipse, and draw the long axis of this ellipse. Bisect the short axis of the inner ellipse, and draw its long axis. It will be seen that the long axes are parallel but do not coincide, and that both are in front of the point which represents the center of the circles.

Each diameter of the larger circle is divided into four equal parts. The four equal spaces on the diameter which forms the short axis appear unequal, according to Rule 9. The diameter which is parallel to the long axes of the ellipses has four equal spaces upon it, and they appear equal. This diameter is behind the long axes, but generally a very short distance; and in practice, if the distance 1 2 between the ellipses measured on the long axis is one-fourth of the entire long axis, then the distance between the ellipses measured on the short axis must be a perspective fourth of the entire short axis. This illustrates the following rule:

Rule 23. Foreshortened concentric circles appear ellipses whose short axes coincide. The distance between the ellipses on the short axis is perspectively the same proportion of the entire short axis, as the distance between the ellipses measured on the long axis, is geometrically the same proportion of the entire long axis.

Exercise 13. Frames. In the frames are found regular concentric polygons with parallel sides, the angles of the inner polygons being in straight lines connecting the angles of the outer polygon with its center. In polygons having an even number of sides, the lines containing the angles of the polygons form diagonals of the figure, as in the square.

In polygons having an odd number of sides, the lines containing the angles of the polygon are perpendicular to the sides opposite the angles, as in the triangle.

Draw upon large triangular and square tablets the lines shown in Fig. 22. Place the tablets horizontally on the table, or support them vertically, and trace upon the slate the appearance of the edges and all the lines drawn upon them. The tracings illustrate the following rule:

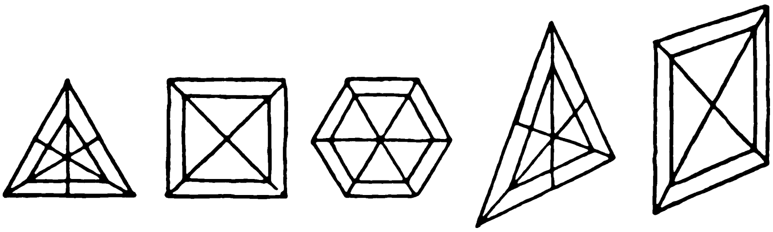


Fig. 22. Frames.

Rule 24. In representing the regular frames, the angles of the inner figure must be in straight lines passing from the angles of the outer figure to the center. These lines are altitudes or diagonals of the polygons.

20. After making the tracings described in the foregoing exercises, draw (not trace) freehand on the slate the various tablets, arranged to illustrate each one of the exercises. This is really drawing from objects, and where the rods are used to connect the tablets the figures are equivalent to geometric solids. After the proportions of the surfaces are correctly indicated, lines connecting the corresponding corners of the tablets should be drawn to complete the representation of solid figures. The lines indicating the rods and those lines which in a solid form would naturally be invisible, may be erased. By the use of the three rods of different lengths, three figures of similar character but different proportions may be obtained. These should each be drawn, but each in a different position.

The following directions, which are based on general principles, apply to all drawing whether from objects or from the flat, for work in pencil or in any other medium; drawing from another drawing, a photograph or a print, whether at the same size or larger, is called working from the flat.

21. General Directions for Drawing Objects. First observe carefully the whole mass of the object, its general proportions and the direction of lines as well as the width of the angles. Then sketch the outlines rapidly with very light lines, and take care that all corrections are made, not by erasing but by lightly drawing new lines as in Fig. 23. By working in this manner much time is saved and the drawing gains in freedom. Where the drawing is kept down to only one line which is corrected by erasure, the line becomes hard and wiry, and there is a tendency to be satisfied with something inaccurate rather than erase a line which has taken much time to produce. There is always a difficulty at first in drawing lines light enough, and it is well for the beginner to make the first trial lines with a rather hard pencil. Practice until the habit of sketching lines lightly is fixed. The ideal is to be able to set down exact proportions at the first touch. This, however, is attained by comparatively few artists, and only after long study, but the student will soon find himself able to obtain correct proportions with only a few corrections.

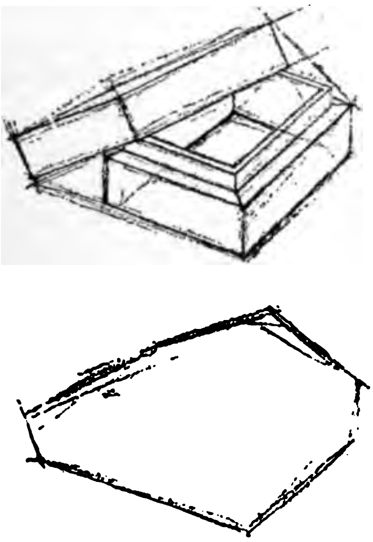


Fig. 23. Blocking in Trial Lines.

22. It cannot be too strongly emphasized that the student must teach himself to regard the subject he is depicting, as a whole, and to put down at once lines that suggest the outline of the whole. This he will find contrary to his inclination, which with the beginner is always to work out carefully one part of the drawing before suggesting the whole.

There are two objections to this; in the first place, much time having been spent on one part, it is almost inevitable that the addition of other portions reveals faults in the completed part, and unnecessary time is consumed in correcting. The second objection is that a drawing made piecemeal is sure to have a disjointed look, even if the details are fairly accurate in their relative proportions.

The idea of unity is lost and some one detail is apt to assume undue importance, instead of all details being subordinated to the general effect of the whole. It is always most important to state the general truths about the subject rather than small particular truths, which impair the general statement. This applies particularly to small variations in the outline which should be omitted until the big general direction or shape has been established.

23. Where an outline drawing is desired, after the correct lines have been found, they should be made stronger than the others and then all trial lines erased. In doing this the eraser will usually remove much of the sharpness of the correct lines so that only a faint indication of the desired result remains. These should be strengthened again with a softer pencil and each line produced, as far as possible, directly with one touch ; in the case of curves and very long lines, breaking the line and beginning a new one as near as possible to the end of the previous line, but taking care that the lines do not lap.

As soon as the student has acquired some proficiency in drawing the single figures made from the tablets, groups of two or three objects should be attempted. Combinations of books or boxes with simple shapes, or vases, tumblers, bowls and bottles will illustrate most of the principles involved in freehand perspective. Outline sketches may be made on the slate first and tested in the usual way, and afterward the same group may be drawn larger on paper. The chief difficulty in drawing a group is to obtain the relative proportions of the different objects. There is the same objection to completing one object and then another as there is to drawing a single object in parts. The whole group must be suggested at once. This can best be done by what is called blocking in, by lines which pass only through the principal points of the group. The block drawing gives hardly more than the relative height and width of the entire group and the general direction of its most important lines. But if these are correct, the subdivision of the area within into correct proportions is not difficult The longer and more important lines of the parts are indicated and short lines and details lost.

24. **Testing Drawings by Measurement.** In drawings which are not made on the slate the following method of testing propor-

tions is usual. With the arm stretched forward to its greatest length, hold the pencil upright so that its unsharpened end is at the top. Move it until this end coincides with the uppermost point of the object. Holding it fixed and resting the thumb against the pencil, move the thumb up and down until the thumb nail marks the lowest point of the object. The distance measured off on the pencil represents the upright dimension. Holding the pencil at exactly the same distance from the eye, turn it until it is horizontal and the end of the pencil covers the extreme left point of the object. Should the height and width be equal, the thumb nail would cover the extreme right edge of the object. If the width is greater than the height, use the height as a unit of measurement and discover the number of times it is contained in the width. Always use the shorter dimension as the unit of measurement. The accuracy of the test demands that the pencil should be at exactly the same distance from the eye while comparing the width and height. In order to insure this, the arm must not be bent at the elbow and must be stretched as far as possible without turning the body, which must not move during the operation. The distance from the eye to the object must not change during the test, and the position of the eye and body is first fixed by leaning the shoulders firmly against the back of the chair and keeping them in that position while the test is taking place. It is equally important in both the upright and horizontal measurement that the pencil be held exactly at right angles to the direction in which the object is seen; *i.e.*, at right angles to an imaginary line from the eye to the center of the object. In either position the two ends of the pencil will be equally distant from the eye. The test should be made several times in order to insure accuracy, as there is sure to be some slight variation in the distances each time. Avoid taking measurements of minor dimensions, as the shorter the distances measured the more inaccurate the test becomes. At the best measurements obtained in this way are only approximately correct, and too much care cannot be taken in order to render the test of use. Applied carelessly, the test is not only valueless, but thoroughly misleading. When there is any great conflict between the appearance of the object and the drawing after it has been corrected by the test, it is often safe to assume some mistake in applying the test and to trust the eye. In such a case the test may be tested by the use of the slate. A few lines and points will be sufficient to indicate the width and height on the slate, and the relative proportions can then be calculated.

The plumb-line affords another method of testing. A thread or a string with any small object for a weight attached to one end, is sufficient. Hold the string so that it hangs vertical and motionless, and at the same time covers some important point in the object. By looking up and down the line the points directly over and under the given point can be determined and the relative distances of other important points to the right and left can be calculated. The plumb-line will also determine all the vertical lines in the object and help to determine divergence of lines from the vertical.

A ruler, a long rod, or pencil held in a perfectly horizontal position is also of assistance in determining the width of angles and divergences of lines from the horizontal.

25. Misuse of Tests. The use of tests may easily be perverted and become mischievous. Since the object of all drawing is to train the hand and eye, it follows naturally that the more the student relies upon tests the less will he depend upon his perceptions to set him right, and the less education will he be giving to his perceptions. There is no greater mistake for a student than to use the measuring test before making a drawing. Spend any amount of time in calculating relative proportions by the eye, but put these down and correct them by the eye, not once but many times before resorting to tests. All the real education in drawing takes place before the tests are made. Let the student remember that the tests may help him to make an accurate drawing, but they will never make him an accurate draftsman in the true sense. Nothing but training the eye to see and the hand to execute what the eye sees, will do that. When the student has reached the end of his knowledge, has corrected by the eye as far as he can, then by applying tests he is enabled to see how far his perceptions have been incorrect. That is the only educational value of the test. Merely to make an accurate drawing with as little mental effort as possible, relying upon test measurements, requires considerable practice and skill in making the tests, but gives very little practice or training in drawing.

26. Light and Shade. Objects in nature, as before explained, detach themselves from each other by their differences in color and in light and shade.

In drawing without color, artists have always allowed themselves a very wide range in the amount of light and shade employed, extending from drawing in pure outline up to the representation of exact light and shade, or of **true values,** as it is called.

Drawings which contain light and shade may be divided into two classes: Form drawing, which is from the point of view of the draftsman, and value drawing, which is from the point of view of the painter.

27. Form Drawing. In form drawing the chief aim, as the name implies, is to express form and not color and texture. In order to do this, shadows and cast shadows are indicated only as far as they help to express the shape. This is the kind of drawing practiced by most of the early Italian masters, and it has been called the Florentine method. It is often a matter of careful outline with just enough shadow included to give a correct general impression of the object. There is usually little variety in the shadow and no subtle graduations of tone, but the shadows are indicated with sufficient exactness of shape to describe the form clearly. Form drawing is a method of recording the principal facts of form with rapidity and ease and of necessity deals only with large general truths. Perhaps its most distinguishing feature is that it does not attempt to suggest the color of the form.

28. Value Drawing. The word value as it is used in drawing is a translation from the French word *valeur*, and as used by artists it refers to the relations of light and dark.

Value drawing represents objects exactly as we see them in nature; that is, not as outline, but as masses of lights and darks. In value drawing the artist reproduces with absolute truth the different degrees of light and shade. While form drawing suggests relief, value drawing represents it, and it also represents by translating them into their corresponding tones of gray, the values of color. In form drawing, a draftsman representing a red object and a yellow one, would be satisfied to give correct proportions and outlines with one or two principal shadows, while a value drawing of the same objects would show not only the relation of the shadows as they are in nature, but also the further truth that the red object was as a whole darker than the yellow one. The light side of the red object might even be found to be darker in **value** or tone than the shadow side of the yellow form.

29. Values. Drawing has been called the science of art, but artists have rarely approved the introduction of scientific methods in the study of drawing, fearing lest the use of formulas should lead to dull mechanical results. Students are left to discover methods and formulas of their own. It is true that every successful draftsman or artist has a method which he has worked out for himself, but he usually feels it to be so much a matter of his own individuality, that he is reluctant to impose it on students, who are likely to confound what is a vital principle with a personal mannerism, and by imitation of the latter injure the quality of personal expression which is so important in all creative work. So there is an inclination among drawing teachers to distrust anything which tends even to formulate the principles of drawing. Recently there has been, however, a distinct advance in the study of these principles, under the leadership of Dr. Denman W. Ross, of Harvard University, who has made it possible for the first time to speak with exactness of colors and values. As Dr. Ross has permitted the use of his valuable scale in this text book, it will greatly assist in making tangible and clear, what would otherwise be obscure and difficult to explain.

The word **values** as used in the text book refers entirely to relations of light and dark. For instance, the value of a given color, is represented by a tone of gray which has the same density or degree of light and dark that the color has. The value of a spot of red paint on a white ground is expressed by a spot of gray paint which appears as dark on the white ground as does the red paint, but from which the color principle has been omitted. A good photograph of a colored picture gives the values of the picture. A poor photograph, on the contrary, distorts the values and blues are often found too light, while reds and yellows will be too dark to truthfully express the values of the original color.

30. The Value Scale. All possible values which can be represented in drawing, lie between the pure whites of paper or pig-

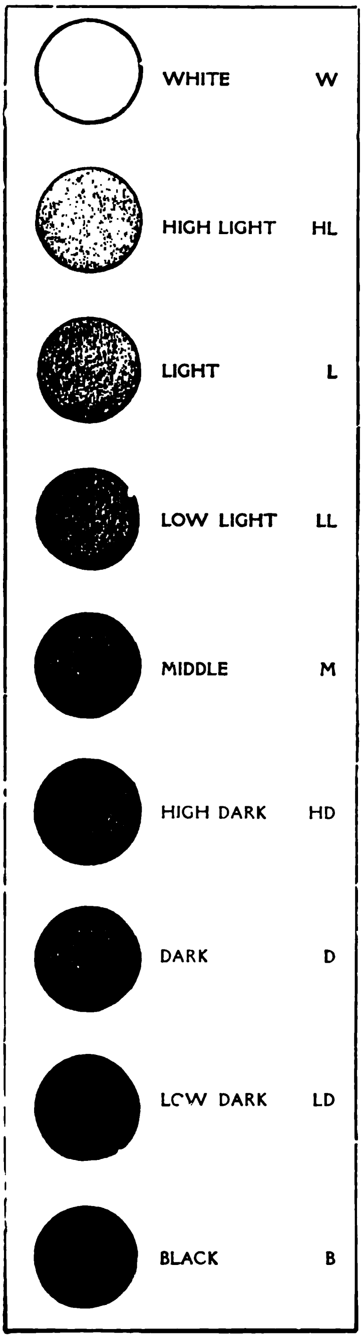


Fig. 24. Value Scale.

ments and the pure black of pencil, ink, or other pigments. In order to think or speak precisely of the great range of values between black and white, it is necessary that they shall be classified in some way. It is not sufficient to say that a given shadow is light, or medium, or dark in value. Dr. Ross has overcome the difficulty by arranging a value scale of nine equal intervals, which covers the whole range from pure white to pure black. Each interval has its appropriate designation and a convenient abbreviation. This scale affords a practical working basis for the study of values. It is evident that while the individual scale does not include all possible values, it can readily be enlarged indefinitely by introducing values between those of the scale as described. As a matter of fact, any differences in value that might come between any two intervals of the scale would rarely be represented, as it is the practice in drawing to simplify values as much as possible; that is to consider the general value of a mass, rather than to cut it up into a number of slightly varying tones which are not necessary for expressing anything of importance in the object.

31. How to Make a Value Scale. Fig. 24 shows a value scale with the names of the intervals and their abbreviations. In making a value scale the student should work in pencil, confining each interval within a circle three-quarters of an inch in diameter. White will be represented by the white paper with a circle penciled about it. Black (B) and white (W) should be established first, then the middle value (M), light (L) and dark (D); afterward the remaining values, low light (LL), high light (HL), low dark (LD) and high dark (HD).

32. How to Use a Value Scale. When the objects to be drawn are neutral in color, that is, are black, white, or gray, the relative values are perceived without special difficulty. When the objects are in color, the draftsman is obliged to translate the color element into terms of light and dark.

In order to determine the value of any surface, it is a help to compare the surface with a piece of white paper held in such a way that it receives the greatest amount of light. It not infrequently happens that two surfaces quite different in color will be of exactly the same value. The student should make a practice of observing the relative values of things about him, even when he is not engaged in drawing.

Place a sheet of white paper in the sunlight as it falls through a window and compare its value with that of white paper further in the room and outside of the sunlight. Try a similar experiment with black. These merely show what everyone may suppose that he knows already — that the less light a surface receives the darker value it appears to have. As a matter of fact, beginners are more ready to accept this truth with regard to color than they are when it relates to black and white.

An instructive way of studying values is to look through a closed window and compare the values of forms outside to the value of the window sash. Even when the sash is painted white, it will often be observed to appear darker than any shadow out of doors.

33. General Directions for Drawing the Examination Plates. The examination plates are planned to give as great a variety to the style of drawing as possible. The architect is called upon to use freehand drawing in two general ways; to make working drawings of ornament, either painted or carved, and to make, for reference, sketches or notes, more or less elaborate, from ornament already in existence, or from buildings either entire or in part, as well as from their landscape setting. This course will not include drawing of architecture and landscape.

In making a working drawing of ornament every shape and curve should be drawn to perfection, with clean, careful lines, in order that there shall be no opportunity for the craftsman who executes the work to interpret it differently from the designer's intention. Light and shade are used sparingly as the exact amount of relief is indicated by sections.

In making sketches or notes, while proportions must be accurately studied, form may be suggested by a much freer quality of line. In a working drawing light and shade may be merely indicated or may be carried to any degree of elaboration. The natural way of teaching this kind of drawing is to work from the objects themselves or from casts. This is not possible in a correspondence course, but all the principles of sketching may be very well taught by drawing from photographs of ornament, and this method has some decided advantages of its own for a beginner. The light and shade in the photograph are fixed, while in sketching objects out of doors it changes constantly, and even indoors is subject to some fluctuation; and then, in the photograph the object is more isolated from its surroundings and so is less confusing to perceive.

In order to train the sense of proportion as thoroughly as possible, the plates are to be executed on a much larger scale than the examples, but at no fixed scale. Plan each drawing to be as large as possible, where no dimensions are given, but do not allow any point in the drawing to approach nearer than one inch to the border line.

34. **Varieties of Shading.** In drawing in pen and ink, all effects of shadow are made by lines, and different values are obtained by varying the width of lines, or of the spaces between the lines, or by both. In any case the integrity of each line must be preserved and there can be very little crossing or touching of shade lines, as that causes a black spot in the tone unless lines cross each other systematically and produce **cross hatching.** With the pencil, however, owing to its granular character one may produce a tone without any lines; a tone made up of lines which by touching or overlapping produce a soft, blended effect, in which the general

direction of the strokes is still visible, or a tone made up of pure lines as in pen work. In general it does not matter so much, as in pen drawing, if lines touch or overlap. Indeed, the natural character of the pencil line leads to a treatment which includes both pure lines and more or less blended effects.

35. **Directions of Shade Lines.** It is always a very important matter to decide what direction shade lines shall take. While it is impossible to give rules for it, a good general principle is to make the direction of the lines follow the contours of the form. The easiest and simplest method is to make all the lines upright. This method is a very popular one with architects. The objections to it are monotony and a lack of expression, but it is certainly a very safe method and far preferable to one where desire for variety has been carried too far and lines lead the eye in a great number of different directions which contradict the general lines of the surface or form. A natural treatment is to adapt the direction of lines to the character of the surface represented; that is, to treat curved surfaces with curving lines and flat planes with straight lines, and in general, lines may very well follow either the contours or the surfaces of the form. In that way variety is obtained and the direction of the shading helps to express the character of the thing represented. This principle must, however, be modified when it leads to the introduction of violently opposing sets of lines. Abrupt transitions must be avoided and the change from one direction to another must be accomplished gradually.

Where a large surface is to receive a tone, the tone can best be made by a series of rather short lines side by side with succeeding series juxtaposed. The lengths of the lines in each of the series must vary considerably in order that the breaks in the lines may not occur in even rows, producing lines of white through the tone. (See Fig. 25.)

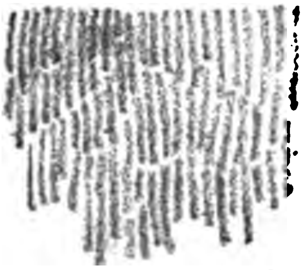


Fig. 25. Method of Breaking Lines Covering a Large Surface.

The crossing of one system of parallel lines by another system is called **cross hatching.** This method probably originated in copperplate engraving, to which it is very well adapted, especially as a means of modifying and deepening tones. It also changes and breaks up the rather stringy texture produced by a succession of long parallel lines. It has now become somewhat obsolete as a general method for pen or pencil drawing, largely because the result looks labored, for it is always desirable to produce effects more simply and directly, that is, with one set of lines instead of two or more. If the tone made by one set of lines needs darkening, it is now more usual to go over the first tone with another set of lines in the same direction.

A great many drawings have been made with shade lines all in a diagonal direction, but this is open to serious objection and should be avoided. A diagonal line is always opposed to the principle of gravitation, and tends to render objects unstable and give them the appearance of tilting. It is often desirable to begin a tone with diagonal lines which, however, should gradually be made to swing into either an upright or horizontal direction.

FREEHAND DRAWING.

Materials Required. One Wolff's solid ink black pencil; one F pencil, one HB pencil; two dozen sheets of paper (same as practice paper of other courses, but to be used for examination sheets in this); one red soft rubber; one medium rubber green or red, with wedge ends, one drawing board; six thumb tacks, one box natural drawing models; one Cross slate; one Cross pencil; one half dozen sheets of tracing paper.

After the preliminary practice with straight lines and curves the student may proceed to execute Plates I and II.

PLATE I.

The principal dimensions in inches are indicated on the model plate. All dimensions and proportions should however be determined by the eye alone. Measurements may be used as a test after the squares are laid in. The figures on the left should be executed first, in order to avoid rubbing by the hand and sleeve.

Figs. 1, 2, 3, 4, 5 are motives from Egyptian painted decoration. Figs. 1, 2, 4 and 5 are all derived from or suggested by patterns produced by plaiting or wearing. The borders of Fig. 3 are derived from bundles of reeds bound together.

As all the figures are large and simple, they should be executed with a rather wide line drawn with the F pencil. Draw the construction lines on this and on all other plates where they are necessary, so lightly that they can be perfectly erased without leaving any indentation in the paper. After the construction lines are drawn out in Figs. 4 and 5, strengthen the lines of the pattern. In erasing, much of the pattern will be removed. This time go over each line with a single stroke of the solid ink pencil. Do not turn the paper in drawing diagonal and vertical lines. They are given especially to train the hand to execute such lines. By turning the paper the exercise becomes one of drawing horizontal lines, which are the least difficult.

Fig. 6 is the skeleton of a very common type of ornament consisting of curved lines radiating from a point at the base, on either side of a central axis.

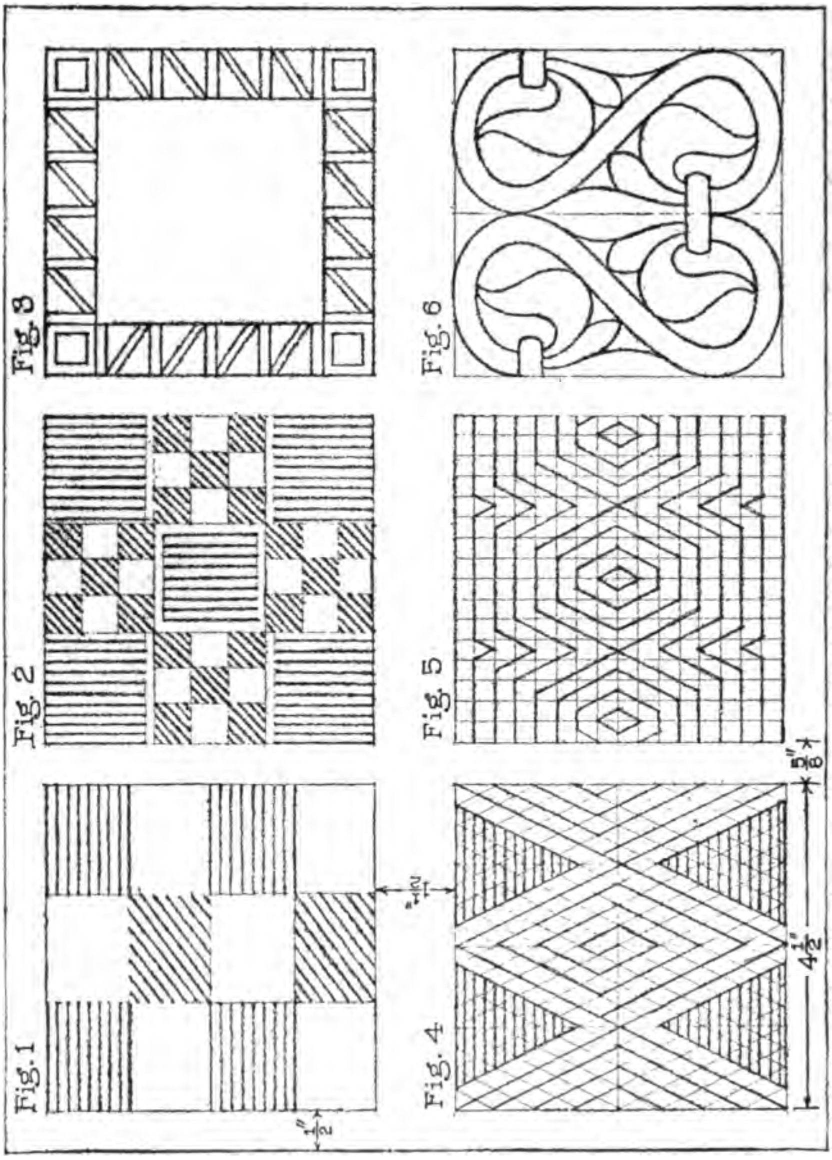


PLATE I.
Motives of Common Types of Ornament.

PLATE II.

Fig. 1 is the basis of a large class of ornament founded on the lines of organic growth, called scrolls or meanders.

Fig. 2 is an Egyptian border consisting of alternate flower and bud forms of the lotus, the most typical and universal of all the Egyptian decorative units. The outline of the flower displays the Egyptian feeling for subtlety and refinement of curve. Observe how the short rounded curve of the base passes into a long subtle curve which becomes almost straight and terminates in a short full turn at the end.

Fig. 3 is a simple form of the guilloche (pronounced geeyōsh), a motive which first becomes common in Assyrian decoration and is afterward incorporated into all the succeeding styles.

Fig. 4 is the skeleton of a border motive where the units are disposed on either side of the long axis of the border.

Figs. 5 and 7 are varieties of the Greek anthemion or honeysuckle pattern, one of the most subtle and perfect of all ornamental forms. Observe in Fig. 5 the quality of the curves—the contrast of full rounded parts with long curves almost straight which characterize the Egyptian lotus. Note in both examples that there is a regular ratio of increase both in the size of the lobes and in the spaces between each, from the lowest one up to the center. It is invariably the rule that each lobe shall be continued to the base without touching its neighbor.

Fig. 6 is an Egyptian "all-over" or repeating pattern painted on wall surfaces. It is made up of continuous circles filled with lotus forms and the intervening spaces with buds.

PLATE III.

This plate is to contain nine outline drawings illustrating Rules 8, 12, 13, 14, 15, 17, 18, 19, 20. The drawings may be made and corrected on the slate and then copied on to the paper or they may be drawn directly on the paper. They may be from the models or from simple geometric objects such as boxes, blocks, cups, pans, plates, spools, flower pots, bottles, etc.

PLATE IV.*

These are characteristic forms of Greek vases. Fig. 1, the Lechy-

---

*Note. This plate and all succeeding ones are to be surrounded by a border line drawn freehand one inch from the edge of the paper.

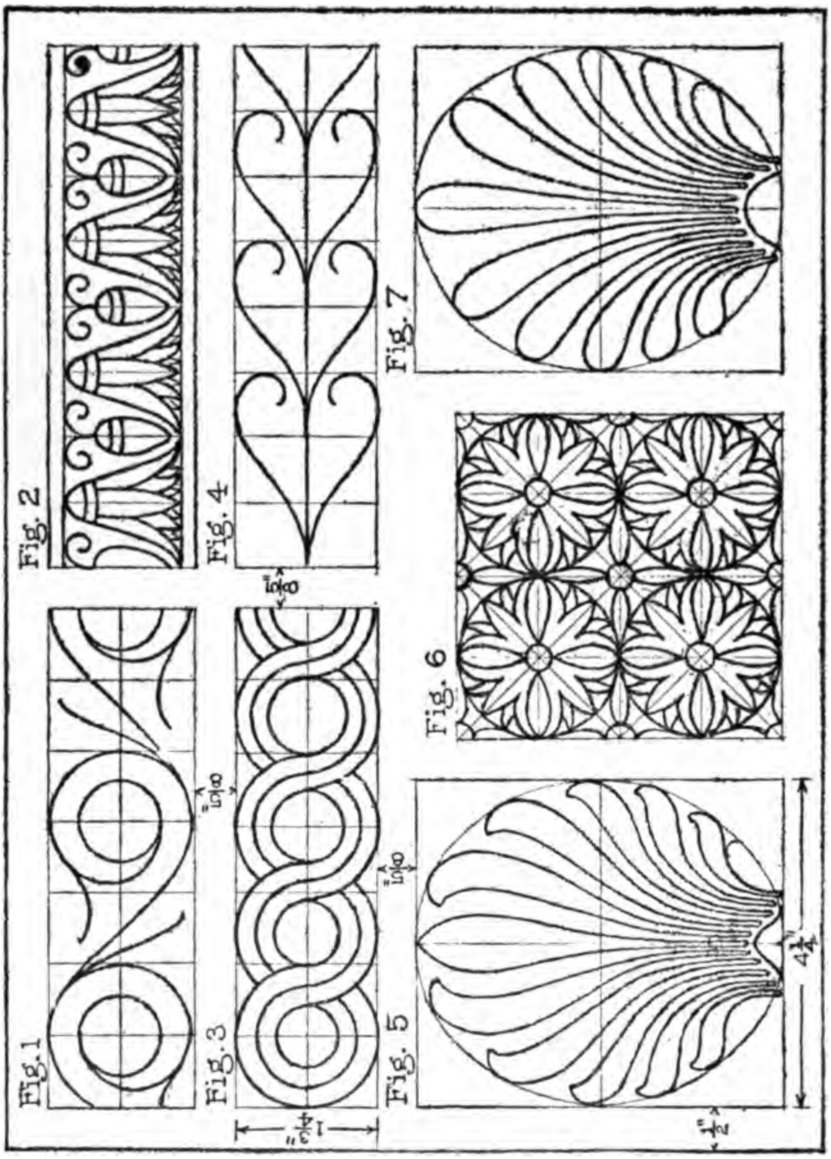


PLATE II.

Typical Egyptian, Assyrian and Greek Motives.

thos, was used to hold oil, Fig. 2, the Kantheros, is one form of the drinking cup, and Fig. 3, the Hydria, for pouring water.

The drawing of these vases includes a great variety of beautiful curves. They are to be executed entirely in outline, and both contours and bands of ornament and the relative sizes of each are to be preserved.

Calculate the heights so that the bases shall each be one inch from above the border line and the upper point of Fig. 3 about one inch below the border line. In sketching them in, first place a construction line to represent the central axis. Across this, sketch the outlines of the horizontal bands and then sketch the contours, following the general directions given in Sections 21 and 25. Remember that lines are to be drawn lightly and corrections made by new lines and not by erasures. Use the arm movement as much as possible in drawing the curves. Before executing the examination paper, practice drawing each vase entirely without corrections of the lines.

PLATE V.

Fig. 1 is from the pavement in the Baptistery at Florence and is in the style called Tuscan Romanesque. The pointed acanthus leaves in the small border at the top, are identical in character with the Byzantine acanthus.

This drawing is to be treated like a sketch made from the object. After sketching in the pattern and correcting in the usual way by drawing new lines, erase superfluous lines and strengthen the outlines by lines made with one stroke. The final outline should, however, be loose and free in character and express the somewhat roughened edges of the pattern in white. This does not mean that the direction of the line must vary enough to distort any shapes. Observe that most of the shapes appear to be perfectly symmetrical only their edges seem slightly softened and broken. Fill in the background with a tone equal to the dark (D) of the value scale. Make this tone by upright lines nearly touching each other and if the value is too light at first, go over them again by lines in the same direction. If a background line occasionally runs over the outline, it will help to produce the effect of the original.

Figs. 2, 3, 4 and 5 comprise typical forms of Greek decorated mouldings. The examples have much the character of a working

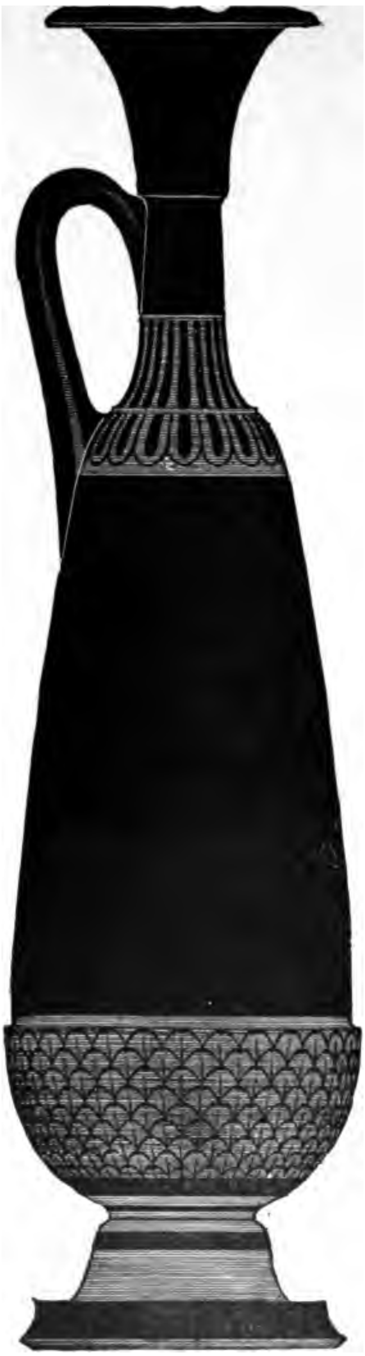


PLATE IV. FIG. 1.
The Lechythos.
Typical Greek Vase Used to Hold Oil

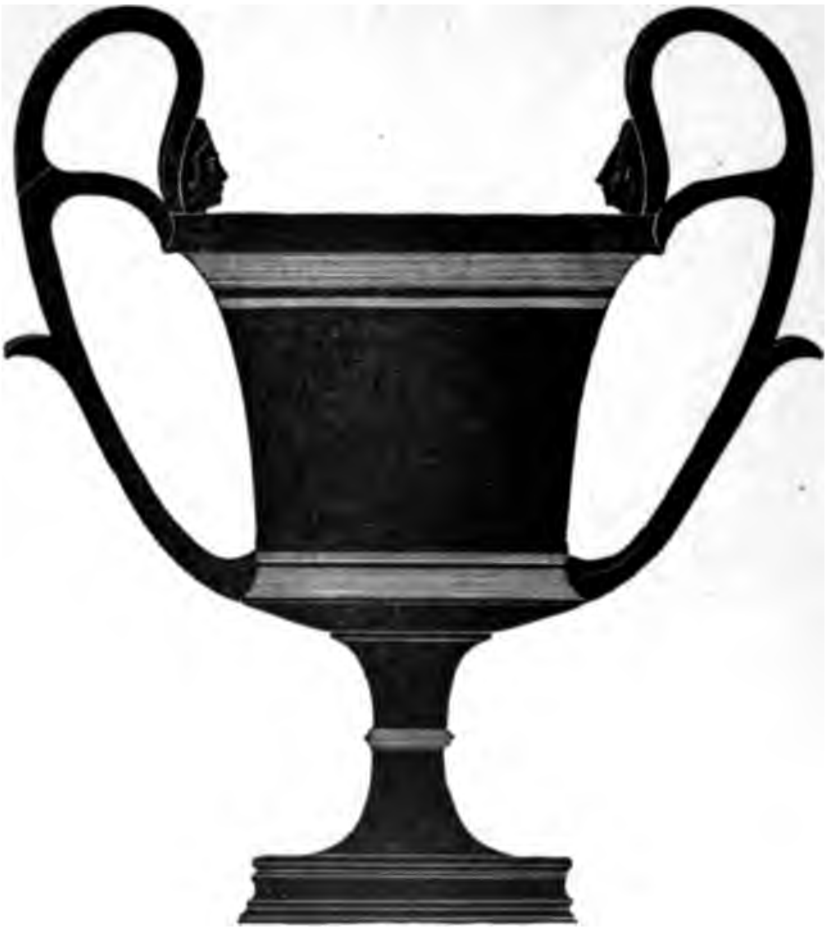


PLATE IV. FIG. 2.
The Kantheros.
Typical Greek Vase Used for a Drinking Cup

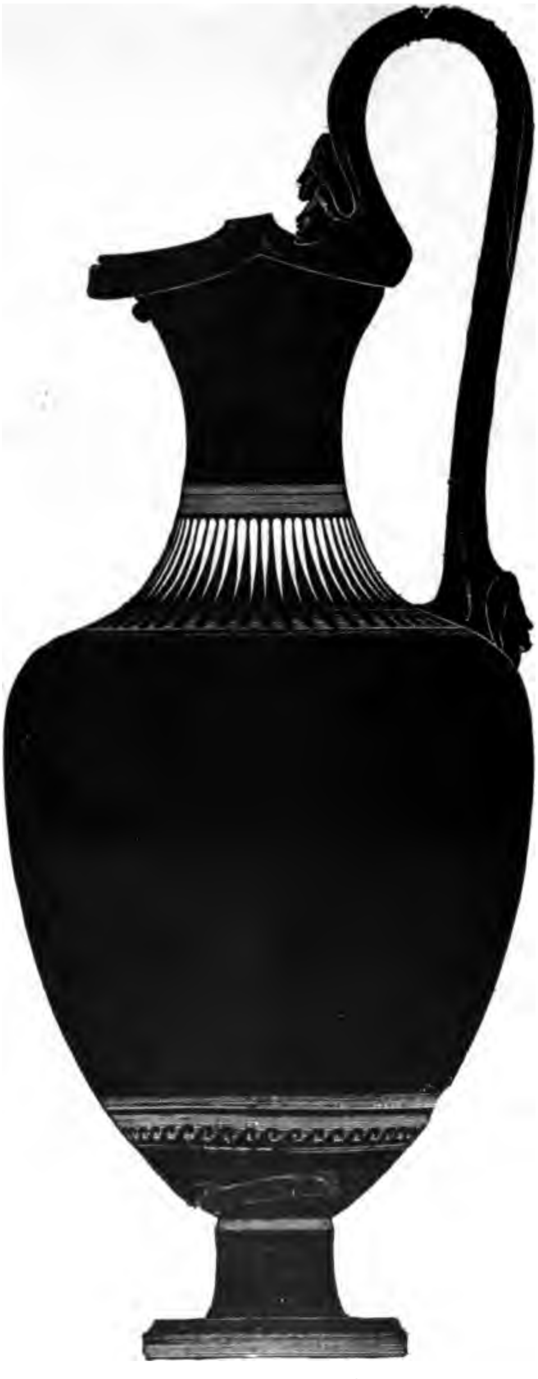


PLATE IV. FIG 3.

The Hydria.

Typical Greek Vase Used for Pouring Water.

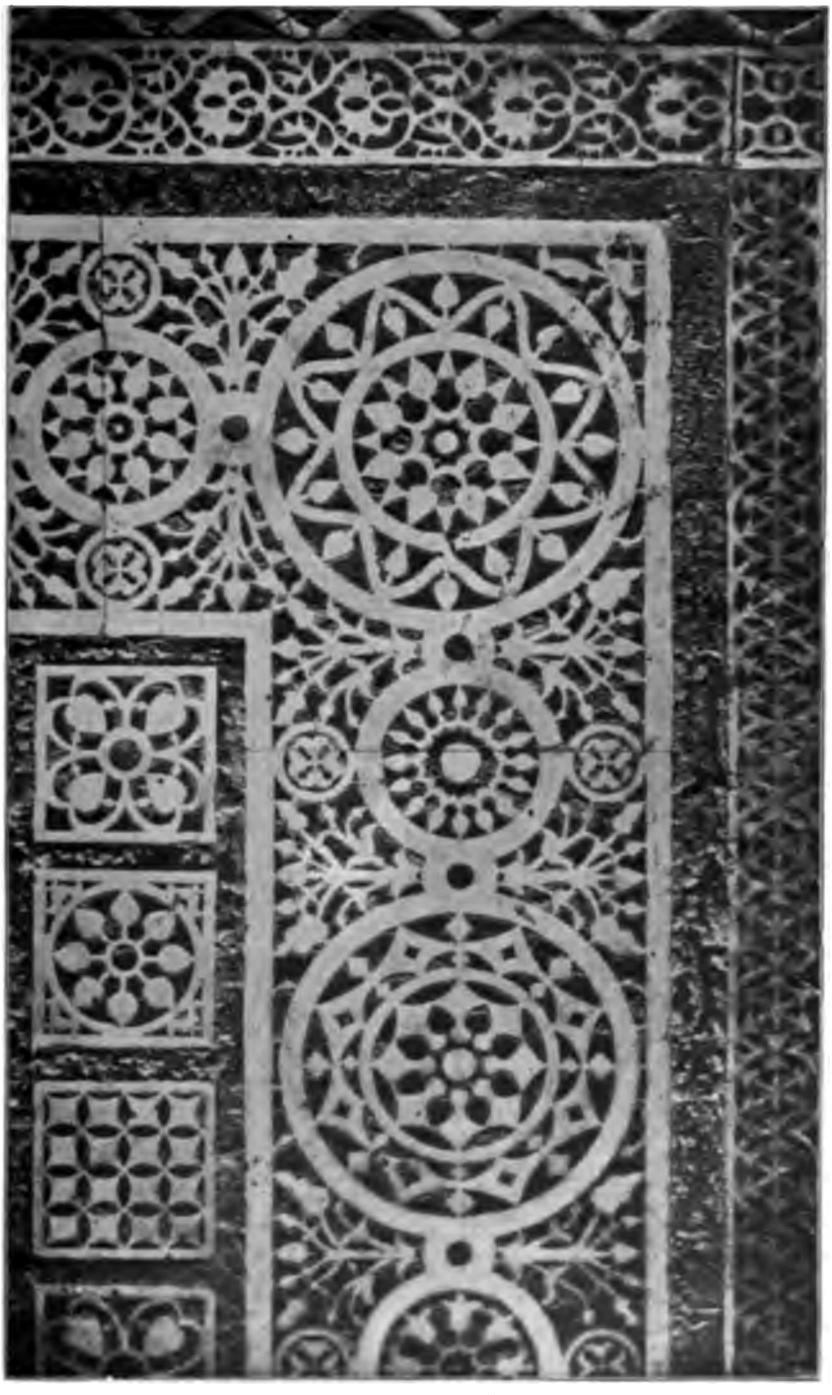
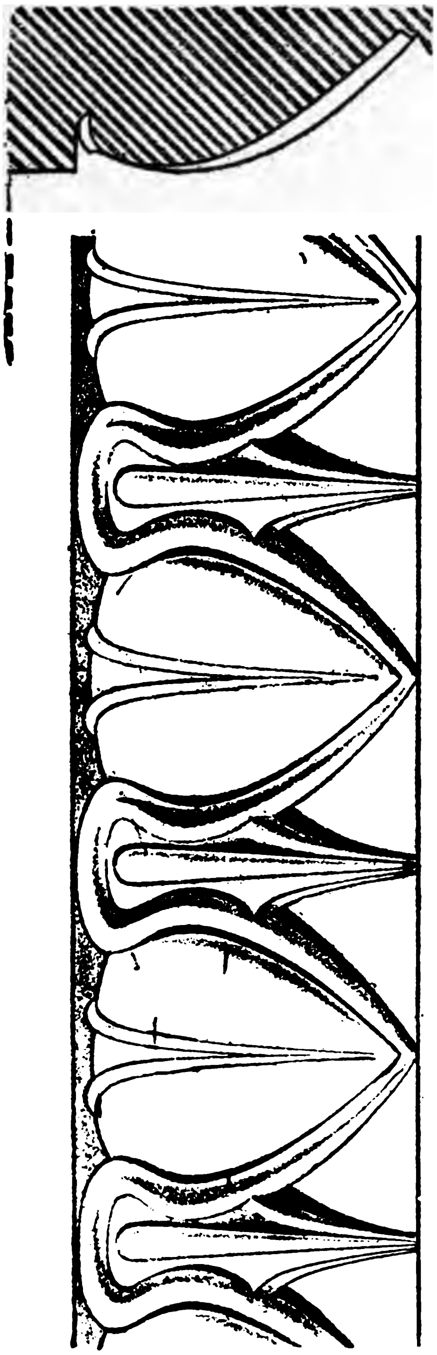


PLATE V. FIG. 1.
Pavement from the Baptistery, Florence.



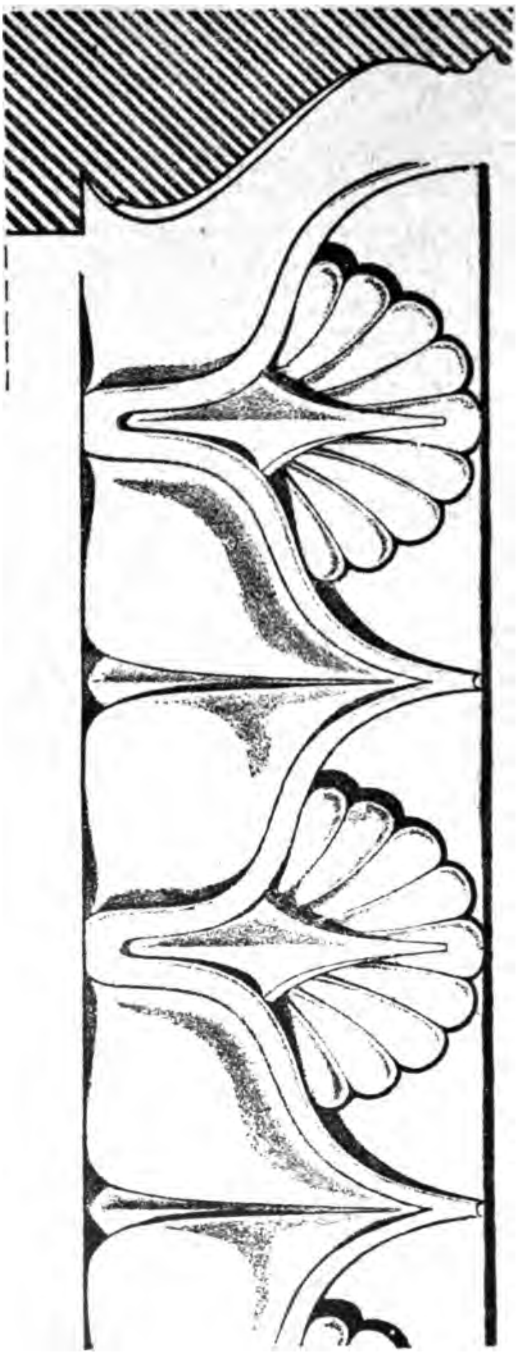
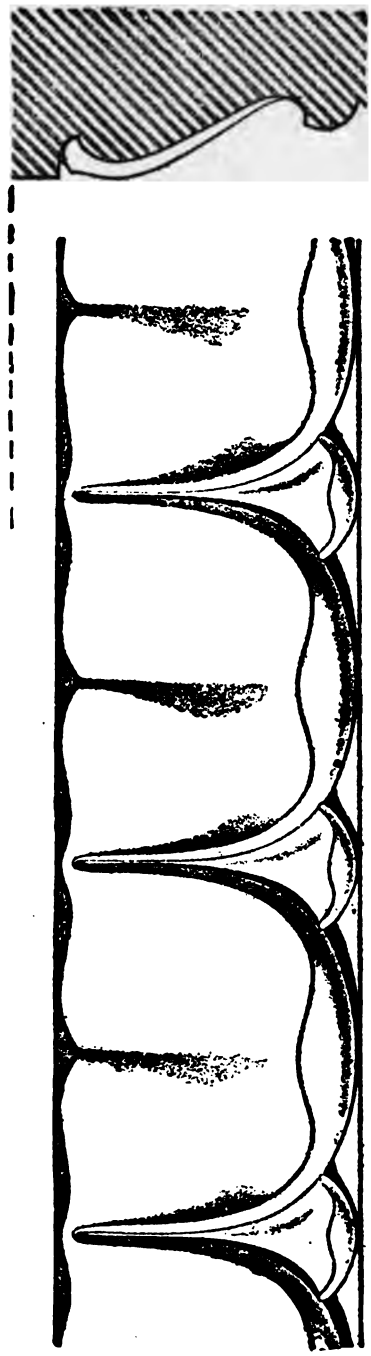


FIG. 2. PLATE V. FIG. 3.

Typical Forms of Greek Decorated Mouldings.



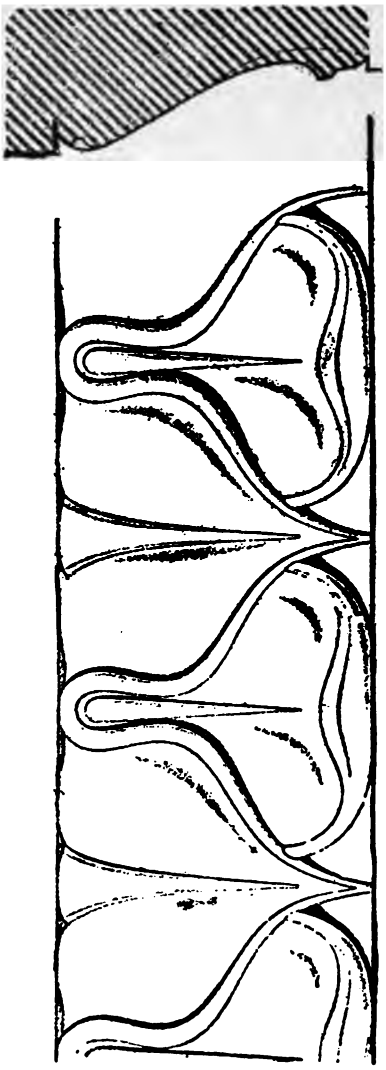


FIG. 4. PLATE V. FIG. 5.

Typical Forms of Greek Decorated Mouldings drawing and the plates are to be enlarged copies, but instead of following the character of the light and shade of the original, the shadows are to be executed by upright lines. (See Section 35.) The darker shadows are to be the value of dark (D) of the scale, the lighter ones the value of middle (M).

PLATE VI.

Place these drawings so that there will be at least an inch between them and about half an inch between the border line and the top and bottom.

Fig. 1 is from a drawing of a wrought iron grille in a church in Prague. Some idea of the shape of the pieces of iron is conveyed by the occasional lines of shading. The pattern will be seen to be disposed on radii dividing the circle into sixths. Construct the skeleton of the pattern shown, establishing first an equilateral triangle and the lines which subdivide its angles and sides. About this draw the inner line of the circle and extend the lines which subdivide the angles of the triangles, to form the six radii of the circle. Complete the outlines of the pattern before drawing the shading lines. This drawing with its lines and curves all carefully perfected represents the kind of working drawing which an architect might give to an ironsmith to work with, although in a working drawing, a section of the iron would be given and each motive of the design would propably be drawn out only once and then as it was repeated it would be merely indicated by a line or two sketched in.

Fig. 2 is from a photograph of a wrought iron grille at Lucca in the style of the Italian Renaissance. The drawing to be made from this, the student must consider to be a sketch, the sort of note or memorandum he might make were he before the original.

The accompanying detail gives a suggestion of the proper treatment. The general shape of the whole outline should be indicated and the larger geometric subdivisions; the details of two of the compartments suggested by light lines and those of the remainder either omitted or very slightly suggested. Try to make the drawing suggest the "hammered" quality of the iron. Although the curves are all beautifully felt, there are slight variations in them produced by the hammer, or they are bent out of shape by time, and the thickness of the iron varies sometimes by intention and sometimes by acci-

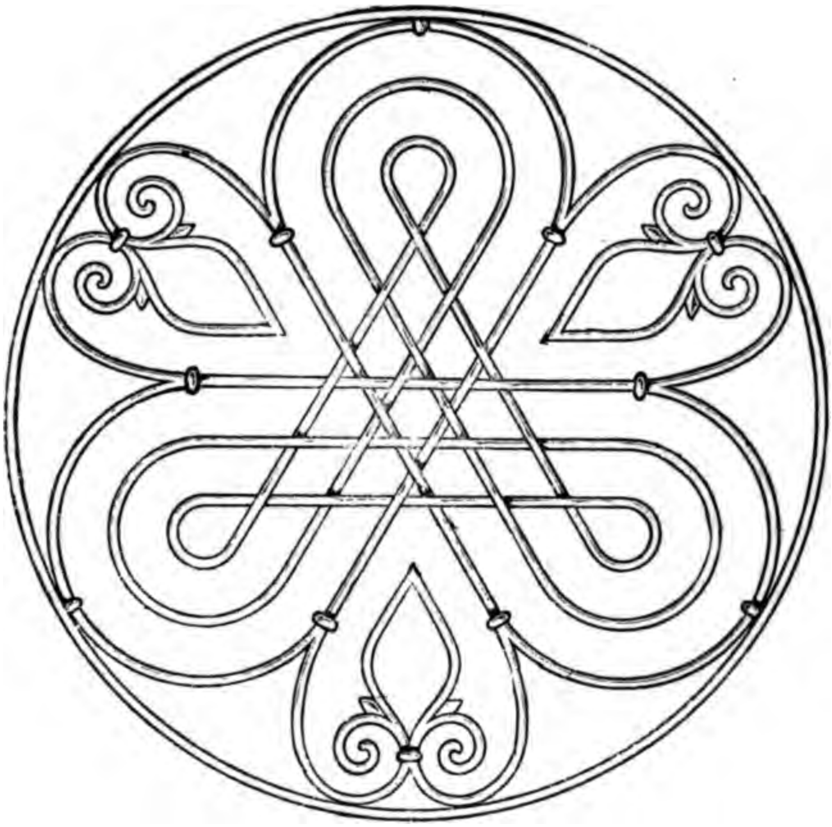


PLATE VI. FIG. 1.
Wrought Iron Grille, Prague.

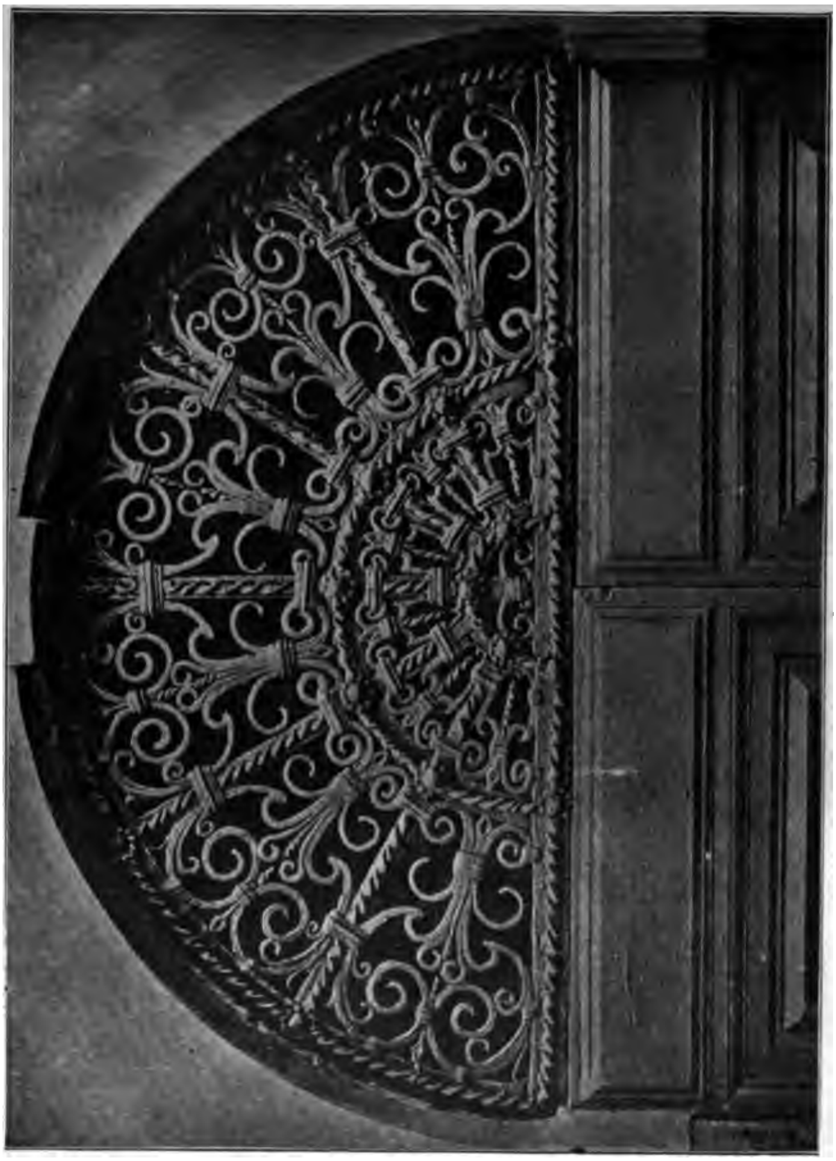
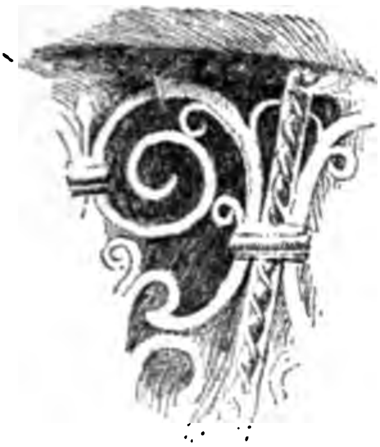


PLATE VI. FIG. 2.
Wrought Iron Grille, Lucca.

dent. Take care, however, not to exaggerate the freedom of the lines and do not carry the variation so far that curves are distorted. Make the drawing in outline first with a line which breaks occasionally, with portions of the line omitted. This helps to indicate the texture of the iron and suggests its free hand-made character.



Detail of Plate VI. Fig. 2

That part of the background which in the photograph appears black behind the iron, should be filled in with a tone equal to the dark (D) of the value scale. It should only be placed behind the two compartments which are most carefully drawn, with perhaps an irregular patch of it in the adjoining compartment. In making the background use single pencil strokes, side by side, with the solid ink pencil, very near together or occasionally touching. Give a slight curve to each stroke. The direction of the lines may be either upright, or they may keep the leading direction of the general lines of the pattern, but they should not be stiff or mechanical. If the value is not dark enough another set of lines may be made over the first ones, keeping the same direction. The only parts of the ironwork itself which require shading are those twisted pieces which mark the subdivision, the outer edge, and the clasp. For this use a tone equal to the middle (M) of the value scale. Avoid explaining too carefully the twists and use the shading only in the dark side. Use a few broken outlines on the right side, just enough to suggest it and do not darken the flat piece of iron behind the twists except on the shadow side. Do not count the number of twists but indicate them in their proper size and the effect will be near enough for this kind of a drawing. Shade only those twists which are nearest the compartments which are detailed; from them let the detail gradually die away.

PLATE VII.

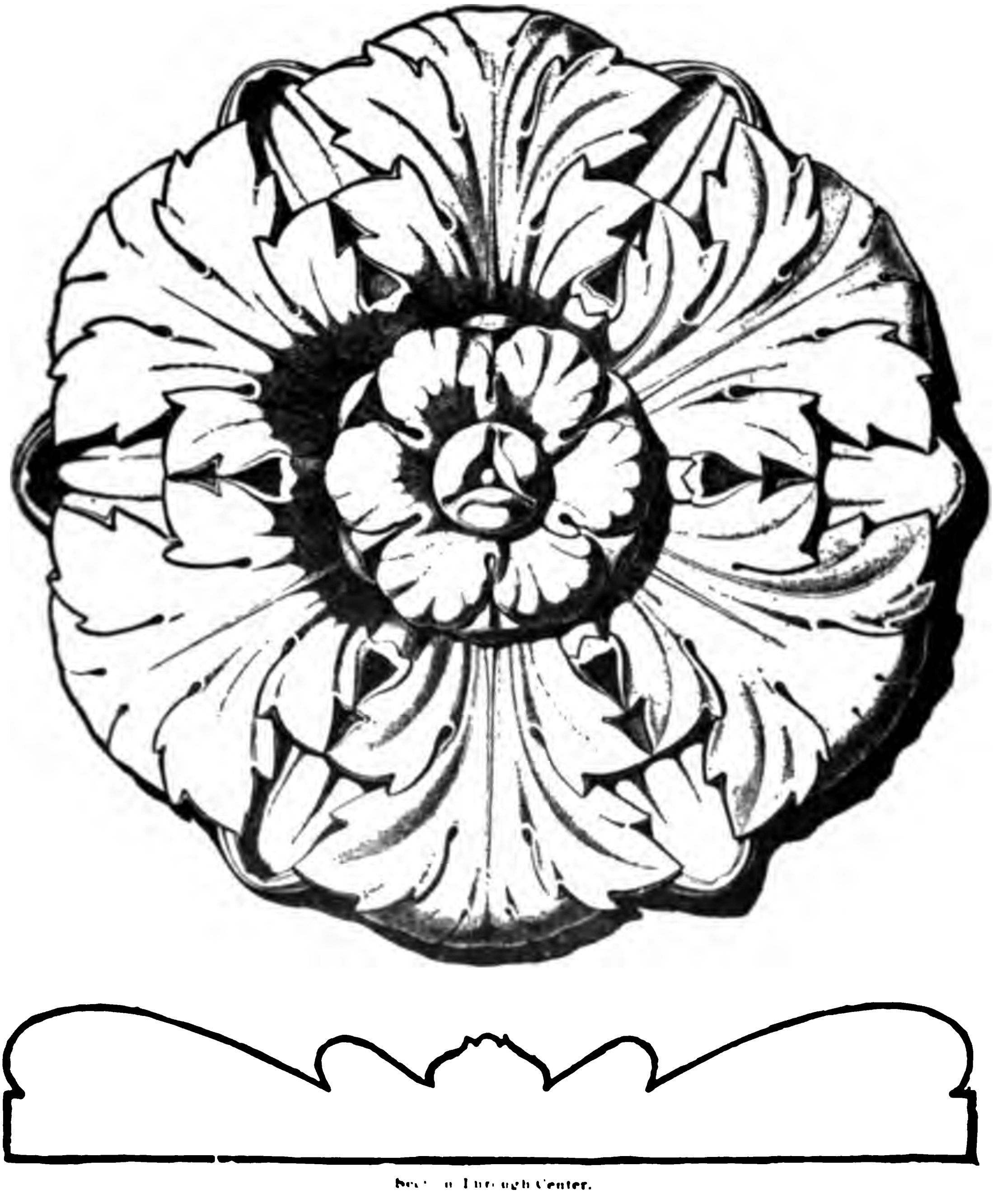
This figure is a rosette made up of the Roman or soft acanthus, and the drawing has the general character of a working drawing. Every part is very clearly expressed in outline, slightly shadowed, and a section explains the exact contours. In drawing the outline of the leaflets, observe that one edge, usually the upper is generally expressed by a simple curve and the other edge by a compound curve, the variation in which, however, is slight. Draw a circle first to contain the outer edge of the rosette and sketch in lightly the main rib or central axis of each leaf. Then block in the general form of the leaves, not showing the subdivisions at edges. Next place the *eyes*—the small elliptical spots which separate one lobe from another—and draw the main ribs of each lobe, finally detailing the leaflets in each lobe. In shading use the value dark (D) for the darkest values and the middle value (M) for the others, and instead of producing a perfectly blended tone as in the original, let the tone retain some suggestion of lines, the general direction of which should follow that of the main ribs in the leaves. In the shadow of the rosette on the background, let the lines be upright. Lines naturally show less in very dark values than in lighter tones, for it is difficult to produce the darker values without going over the lines with another set and that has a tendency to blend all the lines into a general tone.

PLATE VIII.

Plate VIII is a sculptured frieze ornament introducing various forms of the Roman or soft acanthus. In this as in all scroll drawing, the skeleton of the pattern should be carefully drawn, then the leaves and rosettes disposed upon it. Always draw the big general form of the acanthus, and proceed gradually to the details as described in the directions for Plate VII. This like Plate VII, has the general character of a working drawing, only in this case there is no section. Use the same values and same suggestions for directions of line as in Plate VII.

PLATE IX.

This plate is an example of the Byzantine acanthus on a fragment in the Capitoline Museum. In drawing this, place the central axis or main rib of the leaf first, then establish the position of the eyes—the egg-shaped cuts which separate the lobes. The general contour of the lobes and their main ribs should next be blocked in before the final disposition of the points or leaflets is determined.



Section Through Center.

PLATE VII.

Acanthus Rosette

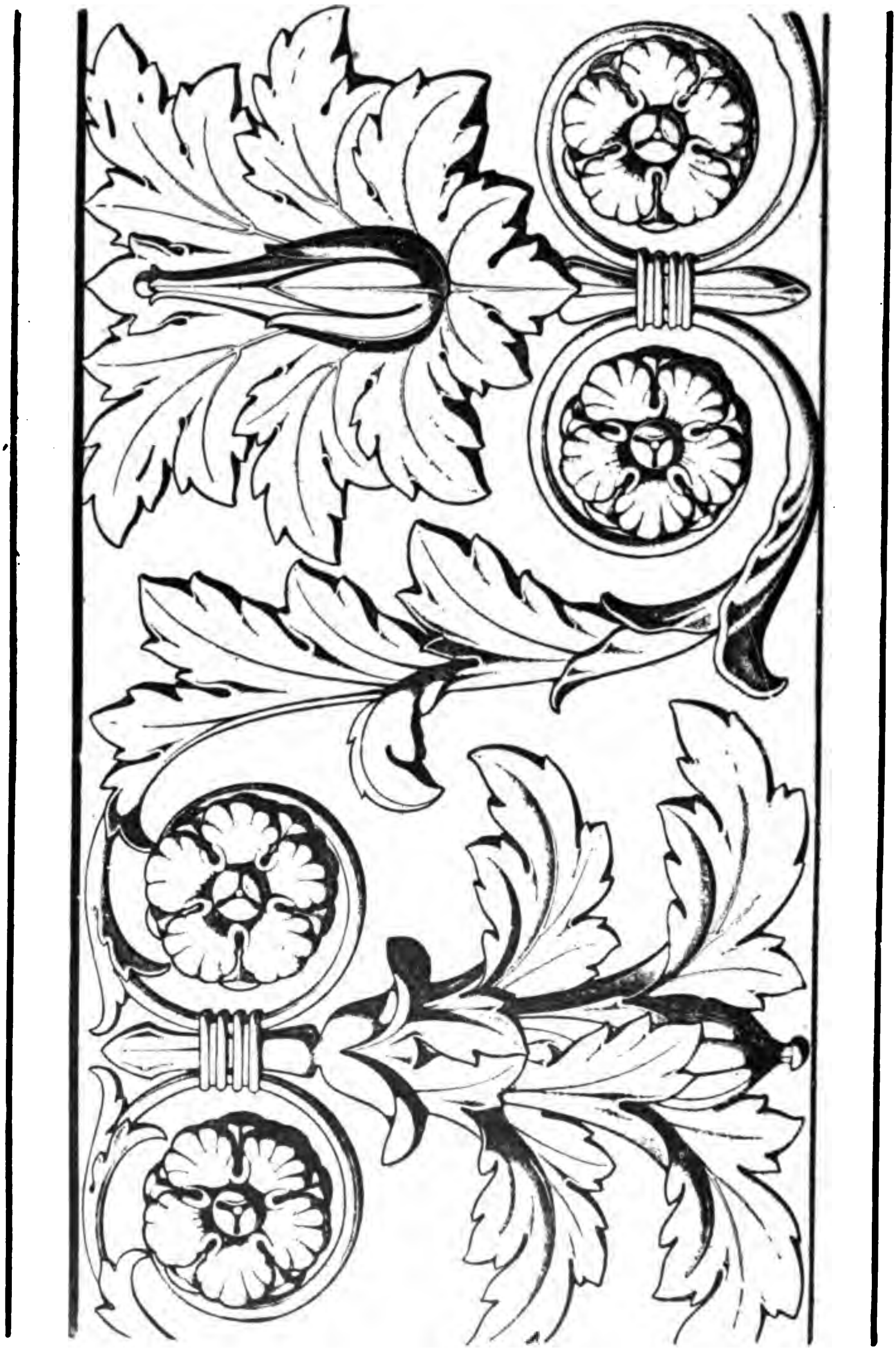


PLATE VIII.
Acanthus Frieze

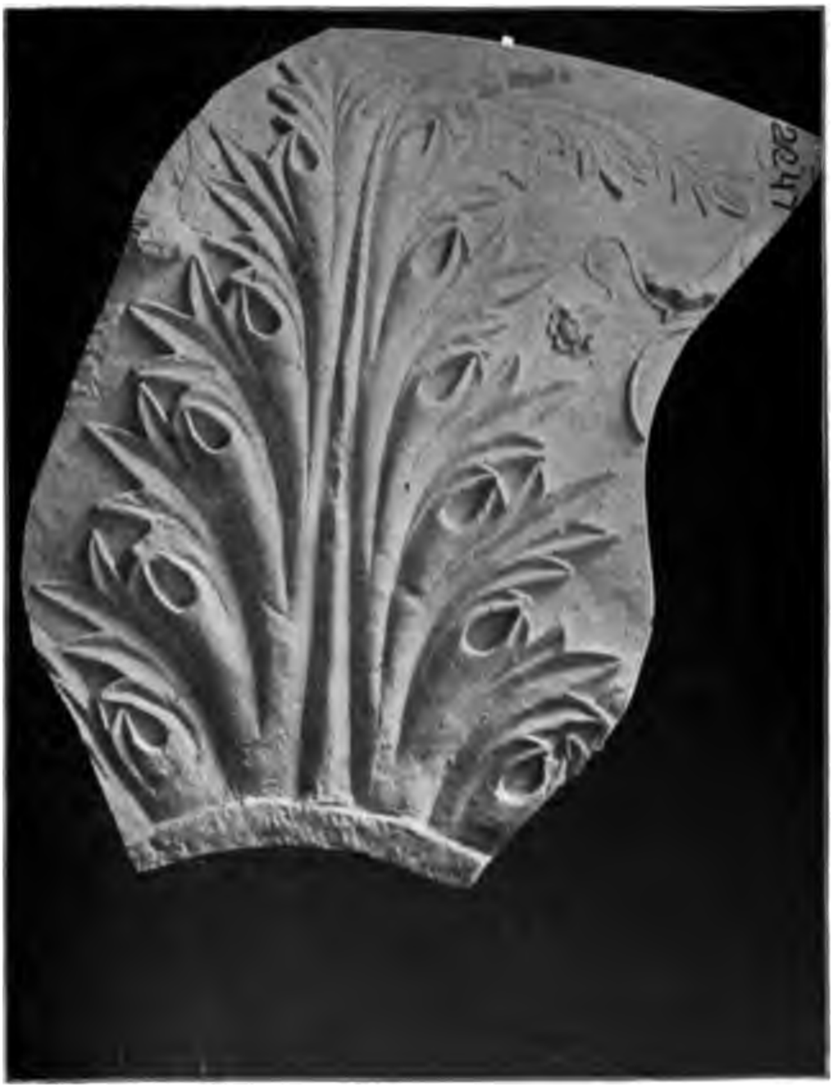


PLATE IX.

This is also to be drawn as Fig. 1 Plate X.

Byzantine Acanthus, from a fragment in the Capitoline Museum

The drawing of this plate is to be enlarged to about ten inches in height and well placed on the sheet with the center of the drawing coinciding with the center of the plate. This drawing is to be made by the use of two values only, with white, and the student may select his own values. The object is to select the most important features and to omit as much as possible. It would be well for the student to first try to see how much he can express with one value and white. The values are to be obtained by upright lines. Outlines are to be omitted as far as possible in the finished sketch and forms are to be expressed by the shapes of the masses of shadow. Where only two values and white are to be used, it is desirable to leave as much white as possible and not allow the shadow values to run too near to black as that produces too harsh a contrast with the white. On the other hand, if the shadow values are too high in the scale, that is too near white, the drawing becomes weak and washed out in effect. As this drawing is to be large in scale, it should be made with the solid ink pencil and with wide pencil strokes. After the outline has been sketched in, the shading or "rendering" may be studied, first on tracing paper over the drawing. There should be no attempt at rendering the background in this drawing.

PLATE X.

Figs. 1 and 2 are to be placed on this plate, but Fig. 1 is to be rendered this time as near to the **true values** as it is possibie to go by using four values and white in shading. The pencil lines should be blended together somewhat, but the general direction of the shading should follow the central axis of the lobes. Only the leaf itself is to be drawn and the background value should be allowed to break in an irregular line about the leaf. It should not be carried out to an edge which would represent the shape of the entire fragment of stone on which the leaf is carved. In studying the shapes of the different shadows it is well at first to exaggerate somewhat and give each value a clean, definite shape even if the edges appear somewhat indefinite in the original. At the last those edges which are blurred may be blended together.

Fig. 2 is a Byzantine capital from the church of San Vitale, at Ravenna. This is to be drawn so that the lines of the column shall fade off gradually into nothing and end in a broken edge instead of stopping on a horizontal line as in the original. The top of the drawing above the great cushion which rests on the capital proper should also fade off into nothing and with a broken line instead of the horizontal straight line. A small broken area of the background value should be placed either side of the capital. In drawing an object like this which is full of small detail there is danger of losing the larger qualities of solidity and roundness by insisting too much upon the small parts and there is also danger of making the drawing too spotty. It is a good principle to decide at first that the detail is to be expressed either in the shadow or in the light, but not equally in both. This principle is based on one of the facts of vision, for in looking at an object one sees only a comparatively small amount of detail; what falls on either side of the spot on which the eye is focused appears blurred and indistinct. In an object of this kind whose section is circular, one can best express the shape by concentrating the study of detail at the point where the light leaves off and shadow begins, representing less and less detail as the object turns away from the spectator. In this drawing, however, there may be more detail expressed in the shadow than in the light, but remember that outlines of objects in shadow lose their sharpness and become softened. Do not attempt to show all the grooves in the parts in shadow; indicate one or two principal ones and indicate more and more detail as the leaves approach the point where the light begins. There the richness of detail may be fully represented, but as the forms pass into the light, omit more and more detail. Again observe that any small plane of shadow surrounded by intense light, if examined in detail, appears darker by contrast, but if represented as dark as it appears it becomes **spotty** and **out of value.** If observed in relation to the whole object its real value will be seen to be lighter than it appears when examined by itself. Use white and four values to be determined by the student. Guard against too strong contrasts of values within the shadow as it cuts it up and destroys its unity, and in every drawing made, show clearly just which is the shadow side and which is the light. That is, do not place so many shadow values within the light that it destroys it, and do not invade shadows with too many lights and reflected lights. Note that it is characteristic of the Byzantine acanthus to have the points of every tine or lobe touch something; no points are left free, but observe also that the points have some substance and width at the place they touch and must not be represented by a mere thread of light. It would be a mistake to introduce much variety of direction in the lines in this drawing, especially in the shadows, as it would "break it up" too much. The concave line of the contour of the capital may well determine the dominant direction of the lines which should not be very distinct as lines, but should blend considerably into general tones. Wherever a plane of shadow stops with a clean sharp edge the drawing must correspond, for its interest and expressiveness depend upon its power to suggest differences in surface—those surfaces which flow gradually into one another as well as those in which the transitions are sharp and abrupt.

The student should be very scrupulous about using only the values of the scale, and in the lower left corner of each sheet he should place within half-inch squares examples of each value used on the drawing with its name and symbol indicated.

PLATE XI.

This capital, of the Roman Corinthian order, is in the Museum of the Baths of Diocletian in Rome.

The foliated portions consist of olive acanthus, and the student should carefully study the differences between this and the soft acanthus. It will be noted that the greatest difference is in the subdivision of the edges into leaflets. In the soft acanthus there is always a strong contrast of large and small leaflets and the lobes overlap each other, producing a full rich effect and the general appearance is more like that of a natural leaf. In the olive acanthus the leaflets in one lobe differ slightly from each other in size, are narrower, and bounded by simple curves on either side, where the leaflet of the soft acanthus has the compound curve on one side.

The student may use as many values as he thinks necessary, but he should be conscientious in keeping his values in their scale relations and should place an example of each value used, with its name in one corner of the drawing.

To make a satisfactory drawing of a form so full of intricate detail as this is difficult, as there is a great temptation to put in all one sees. The general instructions for drawing Plate VII are equally applicable here. The student should remember that a drawing is an explanation, but an explanation which can take much for granted.

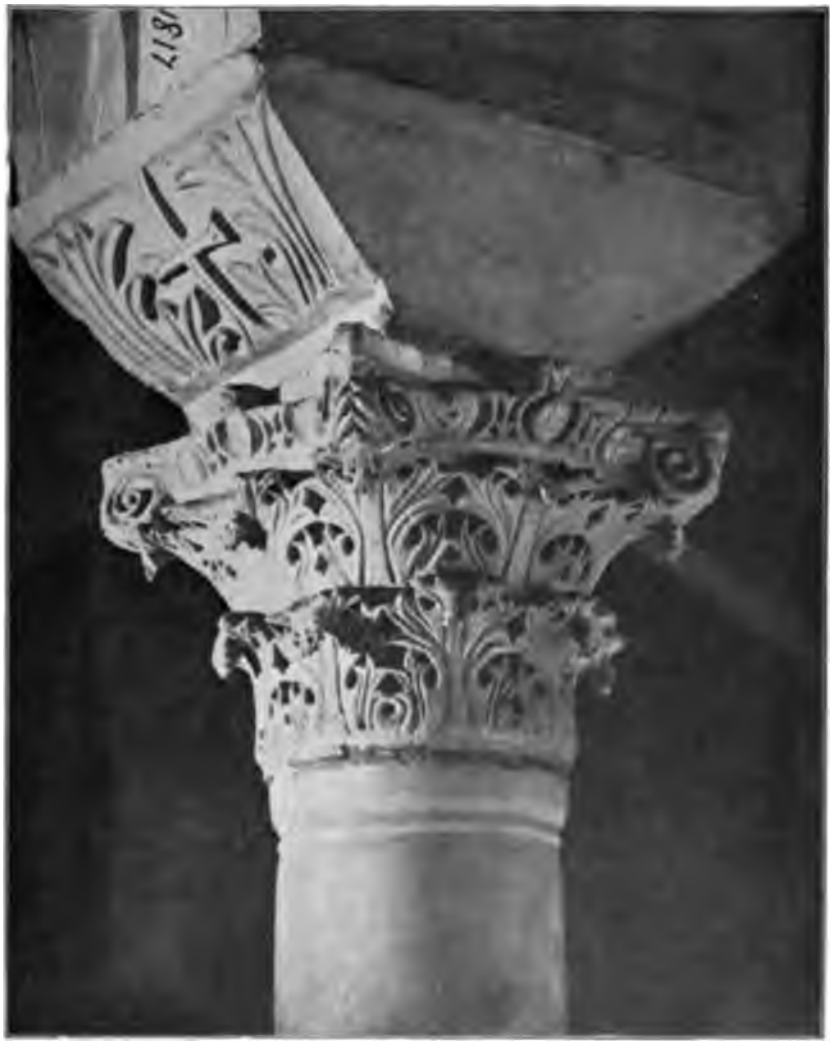


PLATE X. FIG. 2.
Byzantine Capital, from the Church of San Vitale Ravenna.

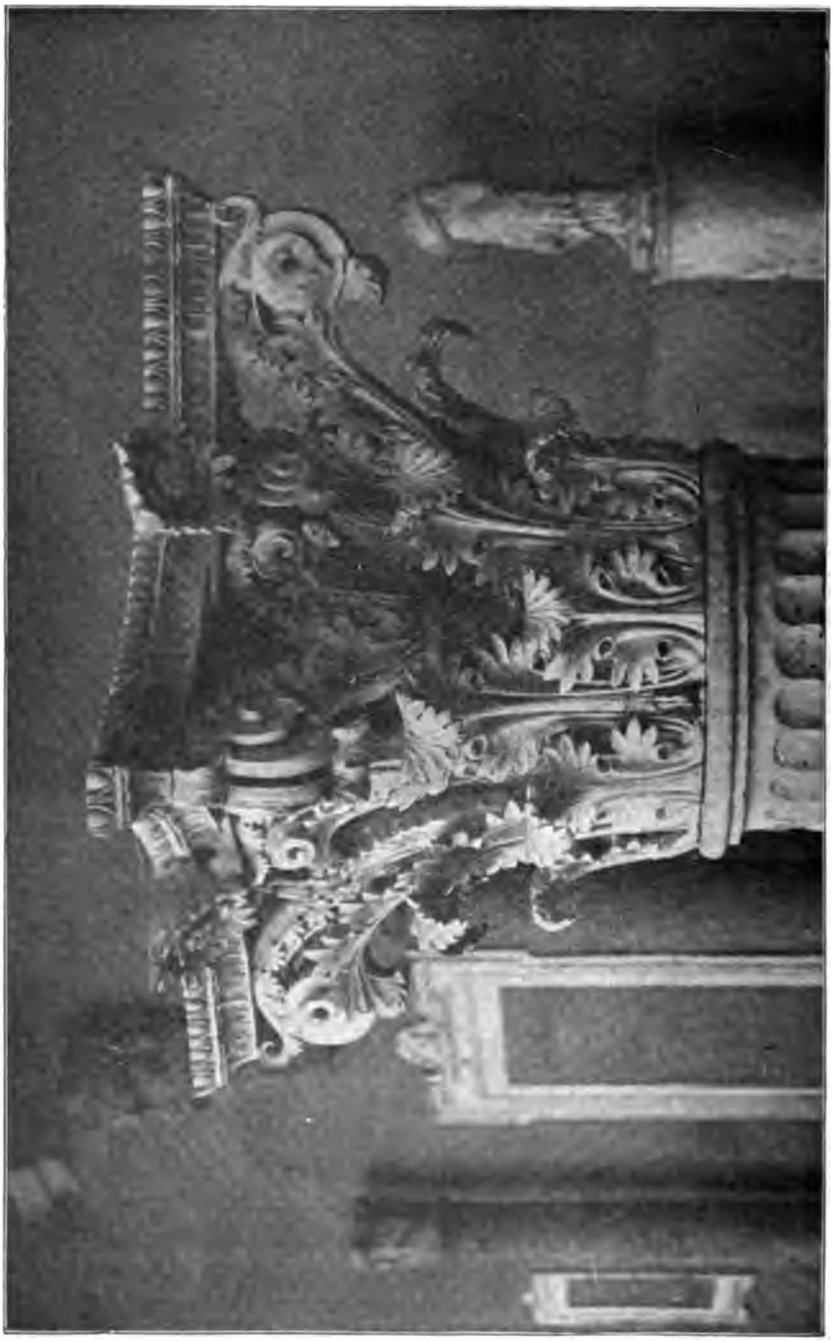


PLATE XI.
Roman Corinthian Capital, from the Baths of Diocletian.

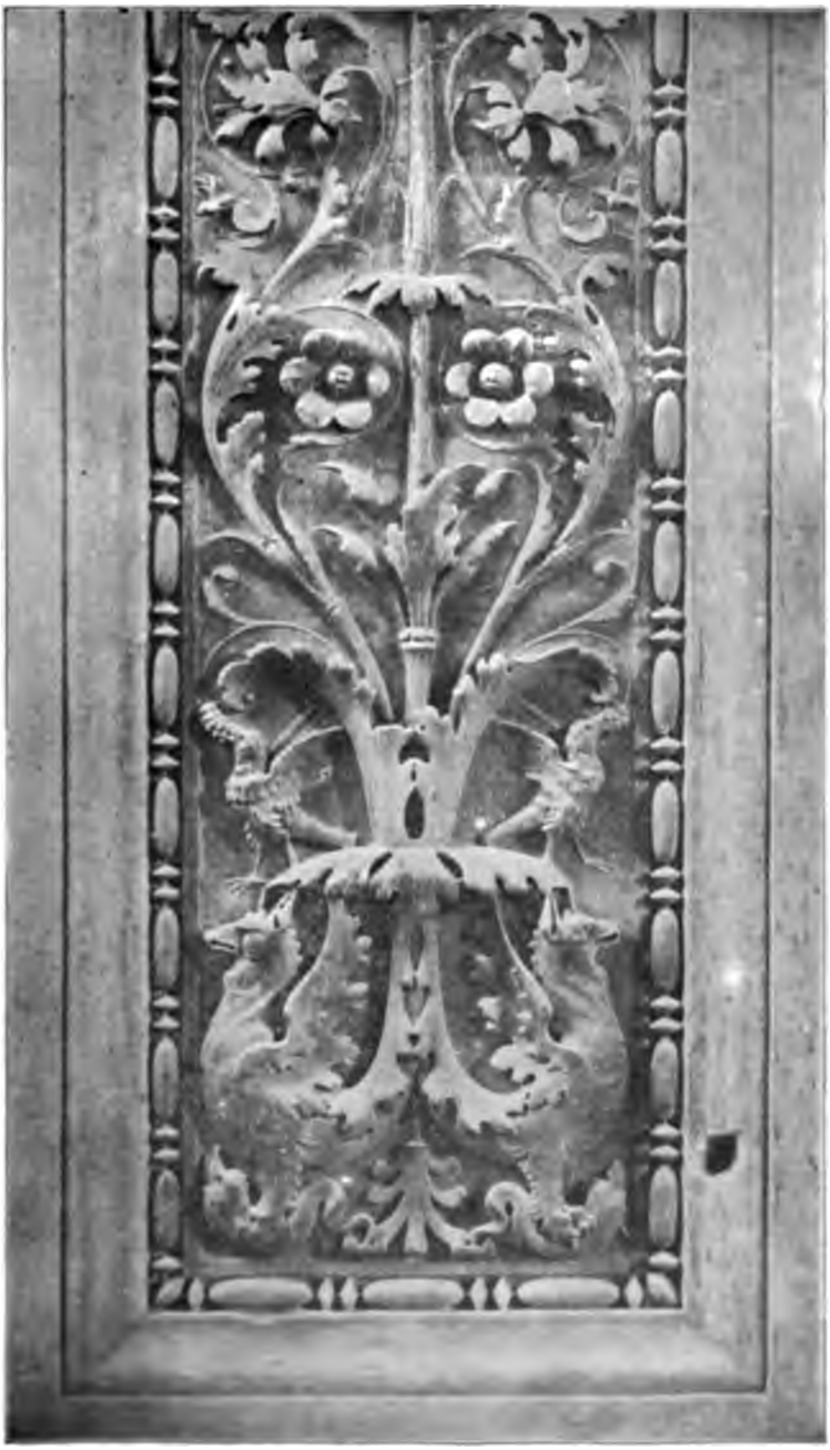


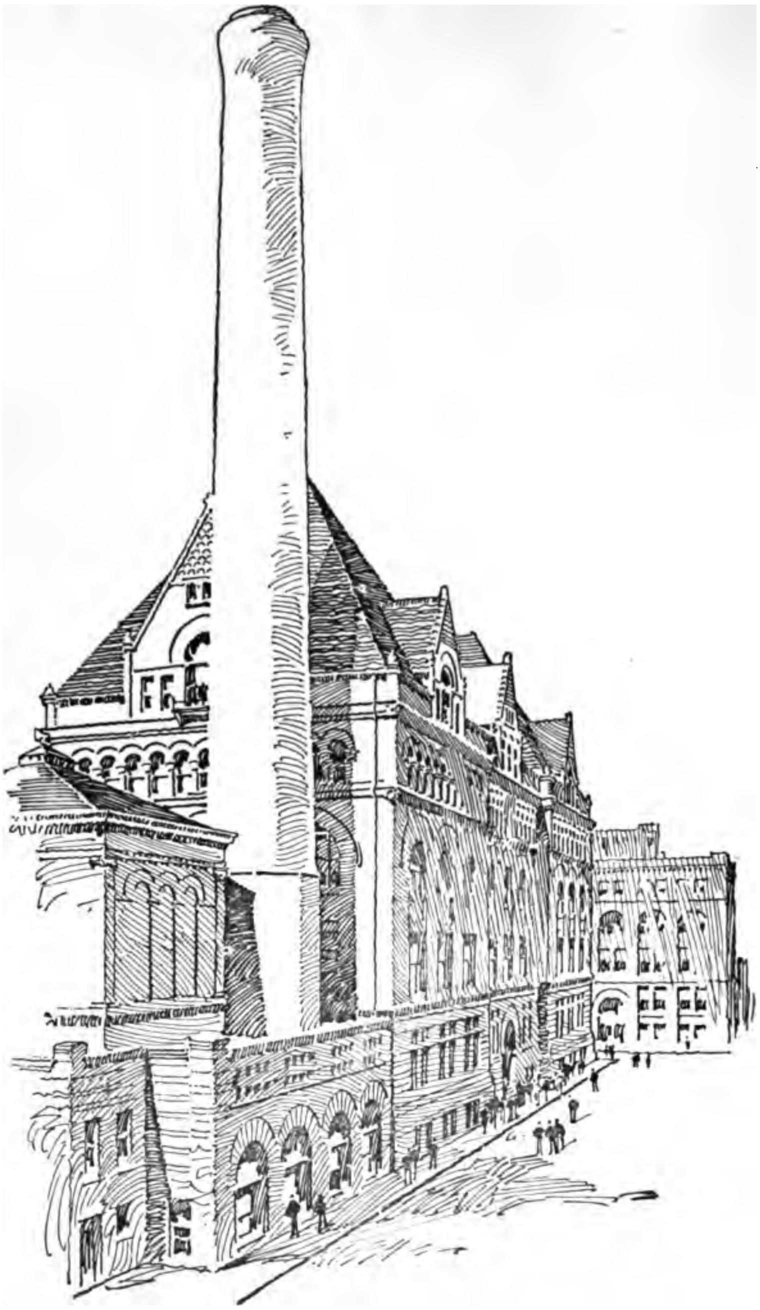
PLATE XII.
Italian Renaissance Pilaster.

For instance, if the carved ornament on the mouldings or at the top of the capital are expressed where they receive full light, they must become more and more vague suggestions and finally disappear in the strong shadows; so the division line between the two mouldings of the abacus may be omitted in shadow and the mind will fill in what the eye does not see. One could go farther and express the detail only for a short space, letting it gradually die away into light or be merely indicated by a line or two, and still the explanation would be sufficient and far less fatiguing to the eye than literal insistence on every detail for the entire length. It is an excellent plan to look at the original, whether a photograph or the real object, with half closed eyes. This helps decidedly to separate the light masses from the darks and shows how much that is in shadow may be omitted.

The smaller lobes on the olive acanthus have no main ribs and lines are carried from the intersection of each leaf toward the base, the section of the leaflet being concave. The section of the leaflets on the soft acanthus is more V-shaped.

PLATE XII.

This is a portion of a pilaster decoration in the Italian Renaissance style. The acanthus is of the soft Roman type, but much more thin and delicate with the eyes cut back almost to the main ribs and a space cut out between each lobe so there is rarely any overlapping of lobes. Lay out construction lines for the scrolls, block in all forms correctly, detailing little by little, so carrying the whole drawing along to the same degree of finish



A TYPICAL PERSPECTIVE DRAWING.

(Rendered in Pen and Ink.)

PERSPECTIVE DRAWING.

DEFINITIONS AND GENERAL THEORY.

1. WHEN any object in space is being viewed, rays of light are reflected from all points of its visible surface, and enter the eye of the observer. These rays of light are called **visual rays**. They strike upon the sensitive membrane, called the retina, of the eye, and form an image. It is from this image that the observer receives his impression of the appearance of the object at which he is looking.

2. In Fig. 1, let the triangular card *abc* represent any object in space. The image of it on the retina of the observer's eye will be formed by the visual rays reflected from its surface. These rays form a pyramid or cone which has the observer's eye for its apex, and the object in space for its base.

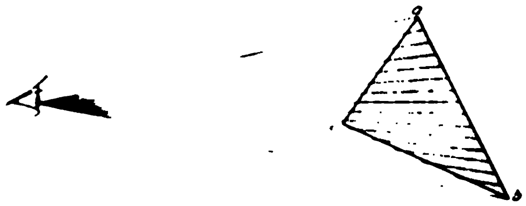


Fig 1 Pyramid of Rays from Object to Eye

3. If a transparent plane M, Fig. 2, be placed in such a position that it will intersect the cone of visual rays as shown, the intersection will be a **projection** of the object upon the plane M. It will be noticed that the projecting lines, or **projectors**, instead of being perpendicular to the plane, as is the case in orthographic projection,* are the visual rays which all converge to a single point coincident with the observer's eye.

---

* In orthographic projection an object is represented upon two planes at right angles to each other by lines drawn perpendicular to these planes from all points on the edges or contour of the object. Such perpendicular lines intersecting the planes give figures which are called projections (*orthographic*) of the object.

4. Every point or line in the projection on the plane M will appear to the observer exactly to cover the corresponding point or line in the object. Thus the observer sees the point a^P in the projection, apparently just coincident with the point a in the object. This must evidently be so, for both the points a^P and a lie on the same visual ray. In the same way the line a^Pb^P in the projection must appear to the observer to exactly cover the line ab in the object; and the projection, as a whole, must present to him exactly the same appearance as the object in space.

5. If the projection is supposed to be permanently fixed upon the plane, the object in space may be removed without affecting the image on the retina of the observer's eye, since the visual rays which were originally reflected from the surface of the object are now reflected from the projection on the plane M. In other words, this projection may be used as a substitute for the object in space, and when placed in proper relation to the eye of the observer, will convey to him an impression exactly similar to that which would be produced were he looking at the real object.

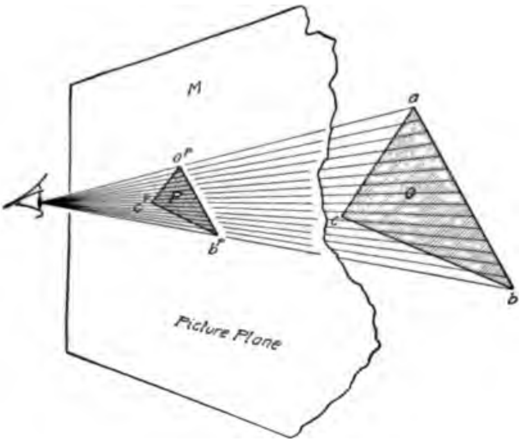


Fig. 2. Diagram Showing Projection of Object on Plane

6. A projection such as that just described is known as a **perspective projection** of the object which it represents. The plane on which the perspective projection is made is called the **Picture Plane.** The position of the observer's eye is called the **Station Point,** or **Point of Sight.**

7. It will be seen that the perspective projection of any point in the object, is where the visual ray, through that point, pierces the picture plane.

8. A perspective projection may be defined as the represen-

tation, upon a plane surface, of the *appearance* of objects as seen from some given point of view.

9. Before beginning the study of the construction of the perspective projection, some consideration should be given to phenomena of perspective. One of the most important of these phenomena, and one which is the keynote to the whole science of perspective, has been noticed by everyone. It is the *apparent* diminution in the size of an object as the distance between the object and the eye increases. A railroad train moving over a long, straight track, furnishes a familiar example of this. As the train moves farther and farther away, its dimensions apparently become smaller and smaller, the details grow more and more indistinct, until the whole train appears like a black line crawling over the ground. It will be noticed also, that the speed of the train seems to diminish as it moves away, for the equal distances over which it will travel in a given time, seem less and less as they are taken farther and farther from the eye.

10. In the same way, if several objects having the same dimensions are situated at different distances from the eye, the nearest one appears to be the largest, and the others appear to be smaller and smaller as they are farther and farther away. Take, for illustration, a long, straight row of street-lamps. As one looks along the row, each succeeding lamp is apparently shorter and smaller than the one before. The reason for this can easily be explained. In estimating the size of any object, one most naturally compares it with some other object as a standard or unit. Now, as the observer compares the lamp-posts, one with another, the result will be something as follows (see Fig. 3). If he is looking at the top of No. 1, along the line *ba*, the top of No. 2 is invisible. It is apparently below the top of No. 1, for, in order to see No. 2, he has to lower his eye until he is looking in

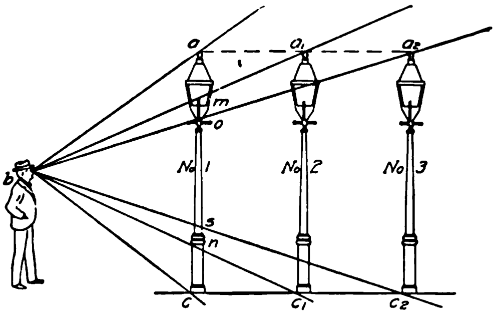


Fig. 3. Diagram Showing Visual Angle

the direction ba_1. He now sees the top of No. 2, but the top of No. 1 seems some distance above, and he naturally concludes that No. 2 appears shorter than No. 1. As the observer looks at the top of No. 2, No. 3 is still invisible, and, in order to see it, he has to lower his eye still farther. Comparing the bottoms of the posts, he finds the same apparent diminution in size as the distance of the posts from his eye increases. The length of the second post appears only equal to the distance *mn* as measured on the first post, while the length of the third post appears only equal to the distance *os* as measured on post No. 1.

11. In the same way that the lamp-posts appear to diminish in size as they recede from the eye, the parallel lines (a, a_1, a_2, etc., and c, c_1, c_2, etc.) which run along the tops and bottoms of the posts appear to converge as they recede, for the distance between these lines seems less and less as it is taken farther and farther away. At infinity the distance between the lines becomes zero, and the lines appear to meet in a single point. This point is called the **vanishing point** of the lines.

12. If any object, say a cube, Fig. 4, is studied, it will be seen that the lines which form its edges may be separated into groups according to their different directions; all lines having the same direction forming one group, and apparently converging to a common vanishing point. Each group of parallel lines is called a **system**, and each line an **element** of the system. For example, in Fig. 4, A, A_1, A_2, and A_3 belong to one group or system; B, B_1, B_2, and B_3, to another; and C, C_1, C_2, and C_3, to a third. Each system has its own vanishing point, towards which all the elements of that system appear to converge. This phenomenon is well illustrated in the parallel lines of a railroad track, or by the horizontal lines which form the courses of a stone wall.

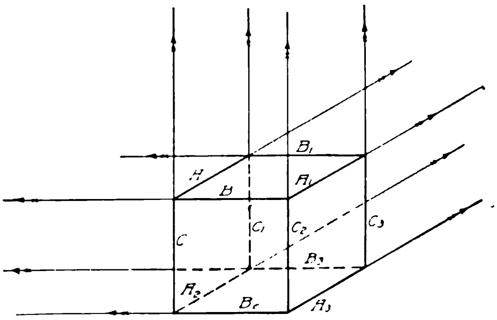


Fig. 4. Diagram Showing Construction Lines for Cube

13. As all lines which belong to the same system appear to meet at the vanishing point of their system, it follows that *if the eye is placed so as to look directly along any line of a system, that line will be seen endwise, and appear as a point exactly covering the vanishing point of the system to which it belongs.*

If, for illustration, the eye glances directly along one of the horizontal lines formed by the courses of a stone wall, this line will be seen as a point, and all the other horizontal lines in the wall will apparently converge towards the point. In other words, the line along which the eye is looking appears to cover the vanishing point of the system to which it belongs. Thus, the vanishing point of any system of lines must lie on that element of the system which enters the observer's eye, and must be at an infinite distance from the observer. Therefore, to find the vanishing point of any system of lines, imagine one of its elements to enter the observer's eye. This element is called the **visual element** of the system, and may often be a purely imaginary line indicating simply the direction in which the vanishing point lies. The vanishing point will always be found on this visual element and at an infinite distance from the observer.

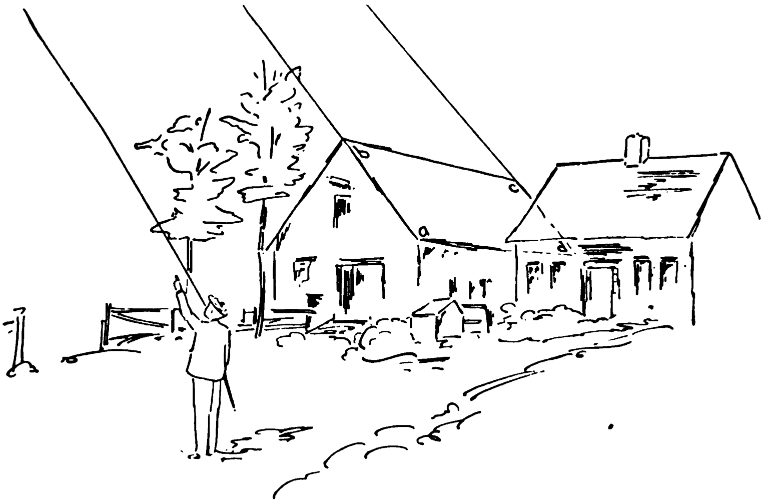


Fig. 5. Sketch Showing Method of Finding Vanishing Point for Construction Lines of an Object

14. To further illustrate this point, suppose an observer to be viewing the objects in space represented in Fig. 5. He desires to find the vanishing point for the system of lines parallel to the oblique line *ab* which forms one edge of the roof plane *abcd*. There are two lines in the roof that belong to this system, namely: *ab* and *dc* If he imagines an element of the system to enter his eye, and looks directly along this element, he will be looking in a direction exactly parallel to the line *ab*, and he will be looking directly at the vanishing point of the system (§ 13). This visual element along which he is looking is a purely imaginary line parallel to *ab* and *dc*. All lines in the object belonging to this system will appear to converge towards a point situated on the line along which he is looking, and at an infinite distance from him.

This phenomenon is of great importance, and is the foundation of most of the operations in making a perspective drawing.

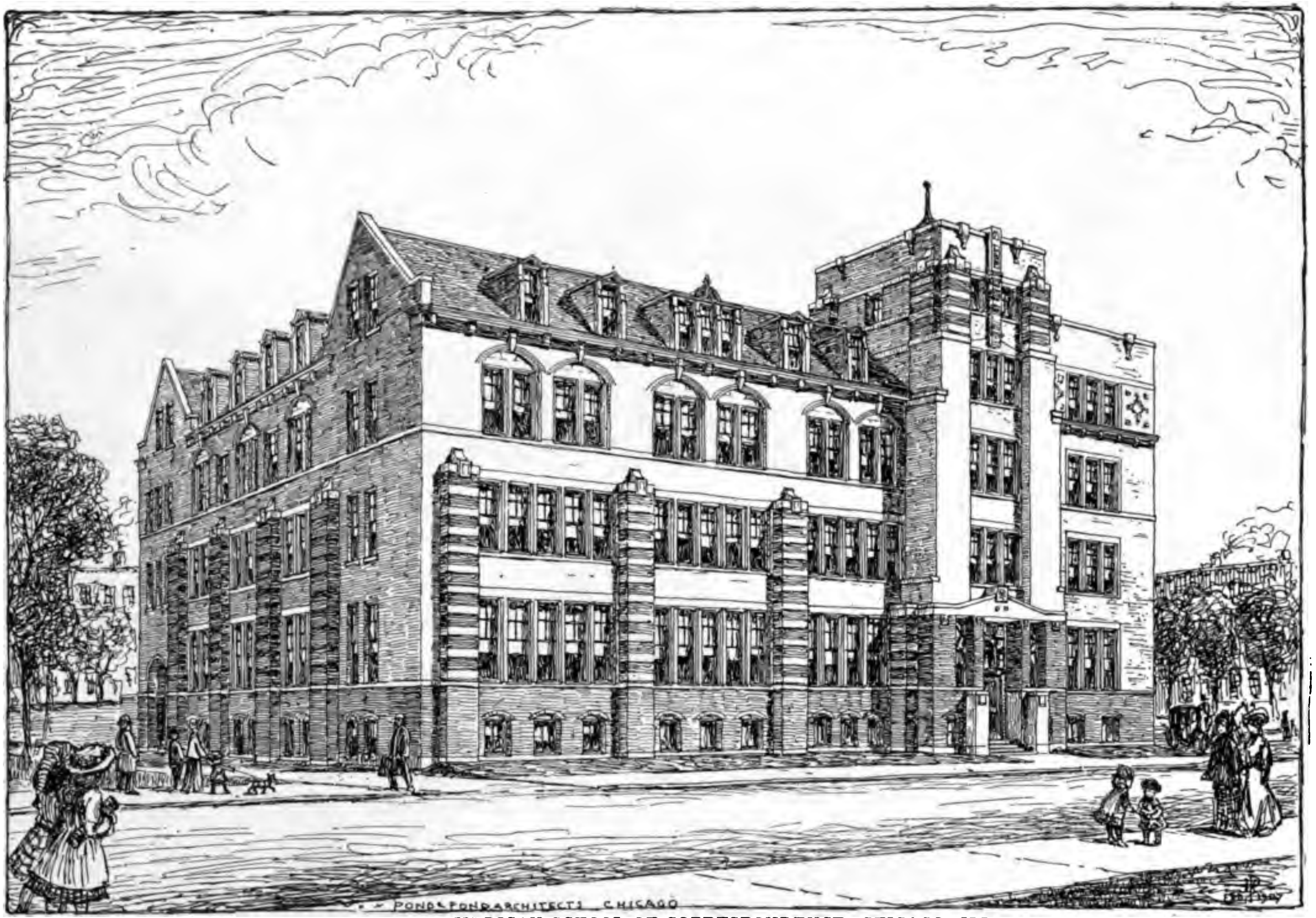
15. The word "vanish" as used in perspective always implies a recession. Thus, a line that vanishes upward, slopes upward as it *recedes* from the observer; a line that vanishes to the right, slopes to the right as it *recedes* from the observer.

16. It follows from paragraphs 13 and 14 that any system of lines that vanishes upward, will have its vanishing point above the observer's eye. Similarly, any system vanishing downward, will have its vanishing point below the observer's eye; any system vanishing to the right, will have its vanishing point to the right of the observer's eye; and any system vanishing to the left, will have its vanishing point to the left of the observer's eye. Any system of horizontal lines will have its vanishing point on a level with the observer's eye, and a system of vertical lines will have its vanishing point vertically in line with the observer's eye.

17. All planes that are parallel to one another are said to belong to the same system, each plane being called an element of the system.

All the planes of one system appear to approach one another as they recede from the eye, and to meet at infinity in a single straight line called the **vanishing trace** of the system. Thus, the upper and lower faces of a cube seen in space, will appear to converge toward a straight line at infinity.

18. If the eye is so placed as to look directly along one of



BUILDING FOR THE AMERICAN SCHOOL OF CORRESPONDENCE, CHICAGO, ILL.

Pond & Pond, Architects, Chicago

Base and Piers of Purple Continental Paving Brick, Laid with a Dark Joint. Body of Wall of Medium Red Paving Brick, Laid with a White Joint. Trimmings of Bedford Stone

the planes of a system, that plane will be seen edgewise, and will appear as a single straight line exactly covering the vanishing trace of the system to which it belongs. The plane of any system that passes through the observer's eye is called the **visual plane** of that system.

19. From § 18, it follows that the vanishing trace of a system of planes that vanishes upward, will be found above the level of the eye, while the vanishing trace of a system of planes vanishing downward, will be found below the level of the eye. The vanishing trace of a system of vertical planes will be a vertical line; and of a system of horizontal planes, a horizontal line, exactly on a level with the observer's eye.

20. The vanishing trace of the system of horizontal planes is called the **horizon.**

The visual plane of the horizontal system is called the **plane of the horizon.** The plane of the horizon is a most important one in the construction of a perspective projection.

21. From the foregoing discussion the truth of the following statements will be evident. They may be called the Five Axioms of Perspective.

(*a*) *All the lines of one system appear to converge and to meet at an infinite distance from the observer's eye, in a single point called the vanishing point of the system.*

(*b*) *All the planes of one system appear to converge as they recede from the eye, and to meet at an infinite distance from the observer, in a single straight line called the vanishing trace of the system.*

(*c*) *Any line lying in a plane will have its vanishing point somewhere in the vanishing trace of the plane in which it lies.*

(*d*) *The vanishing trace of any plane must pass through the vanishing points of all lines that lie in it. Thus, since the vanishing trace of a plane is a straight line* (§ 18), *the vanishing points of any two lines lying in a plane will determine the vanishing trace of the system to which the plane belongs.*

(*e*) *As the intersection of two planes is a line lying in both, the vanishing point of this intersection must lie in the vanishing traces of both planes, and hence, at the point where the vanishing traces of the two planes cross. In other words, the vanishing point* *of the intersection of two planes must lie at the intersection of the vanishing traces of the two planes.*

22. The five axioms in the last paragraph are the statements of purely imaginary conditions which appear to exist, but in reality do not. Thus, parallel lines appear to converge and to meet at a point at infinity, but in reality they are exactly the same distance apart throughout their length. Parallel planes appear to converge as they recede, but this is a purely apparent condition, and not a reality; the real distance between the planes does not change.

23. The perspective projection represents by real conditions the purely imaginary conditions that appear to exist in space. Thus, the apparent convergence of lines in space is represented by a real convergence in the perspective projection. Again, the vanishing point of a system of lines is a purely imaginary point which does not exist. But this imaginary point is represented in perspective projection by a real point on the picture plane.

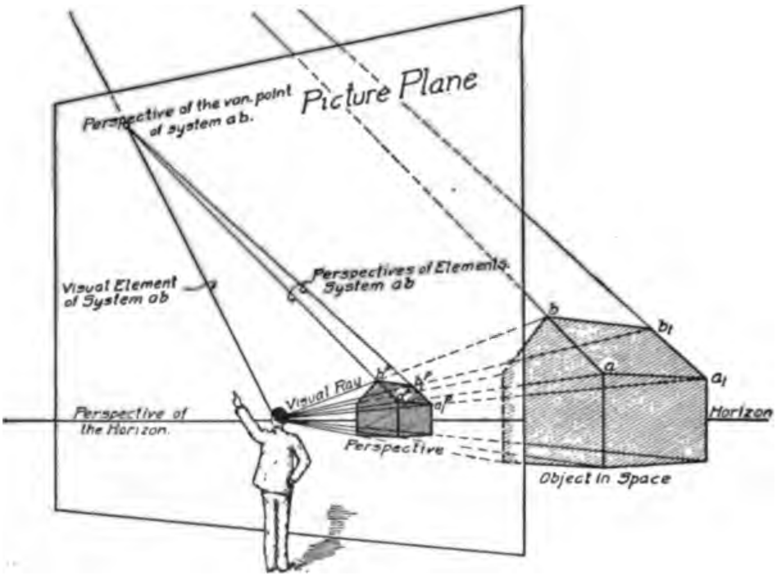

Picture Plane
Perspective of the van. point of system ab.
Visual Element of System ab
Perspectives of Elements System ab
b
b_1
a
a_1
b^p
b_1^p
a_1^p
Visual Ray
Perspective of the Horizon.
Horizon
Perspective
Object in Space

Fig. 6. Diagram Showing Method of Finding Intersection of Visual Element with Picture Plane

From § 14, the vanishing point of any system of lines lies upon the visual element of that system. This visual element may be considered to be the visual ray which projects the vanishing point to the observer's eye. Hence, from § 7, the intersection of this visual element with the picture plane will be the perspective of the vanishing point of the system to which it belongs. This is illustrated in Fig. 6. The object in space is shown on the right of the figure. If the observer wishes to find the vanishing point of the oblique line *ab* in the object in space, he imagines a line parallel to *ab* to enter his eye, and looks along this line (§ 13). Where this line along which he is looking pierces the picture plane, will be the perspective of the vanishing point. Furthermore, the perspective of the line *ab* has been found by drawing the visual rays from *a* and *b* respectively, and finding where these rays pierce the picture plane (§ 7). These points are respectively, a^p and b^p, and the straight line drawn between a^p and b^p is the perspective of the line *ab*. The perspective of the line a_1b_1 which is parallel to *ab*, has been found in a similar way, and it will be noticed that its perspective projection ($a^p_1 b^p_1$) actually converges towards a^pb^p in such a manner that if these two lines are produced they will actually meet at the perspective of the vanishing point of their system.

NOTE. — *It is evident that the perspective of a straight line will always be a straight line, the extreme points of which are the perspectives of the extremities of the given line.*

24. Thus, the five axioms of perspective may be applied to Perspective Projection as follows: —

(*a*) Parallel lines do converge and meet at the vanishing point of their system.

(*b*) Parallel planes do converge and meet at the vanishing trace of their system.

(*c*) The vanishing point of any line lying in a plane will be found in the vanishing trace of the plane.

Therefore, the vanishing points of all horizontal lines will be found in the horizon (§ 20).

(*d*) The vanishing trace of any plane will be determined by the vanishing points of any two lines that lie in it, and must contain the vanishing points of all lines that lie in it.

(*e*) The vanishing point of the intersection of two planes will be found at the intersections of the vanishing traces of the two planes

To the five axioms of perspective projection already stated may be added the following three truths concerning the construction of the perspective projection: —

(*f*) The perspective of any point in space is where the visual ray through the point pierces that picture plane (§ 7).

(*g*) The perspective of the vanishing point of any system of lines is where the visual element of that system pierces the picture plane.

Rule for finding the perspective of the vanishing point of any system of lines:—Draw an element of the system through the observer's eye, and find where it pierces the picture plane.

(*h*) Any point, line, or surface which lies in the picture plane will be its own perspective, and show in its true size and shape.

25. Knowing how to find the perspective of any point, and how to find the vanishing point of any system of lines, any problem in perspective may be solved. Therefore, it may be said that the whole process of making a perspective projection reduces itself to the problem of finding where a line pierces a plane.

Before proceeding farther, the student should review the first twenty-five paragraphs by answering carefully the following questions: —

(1) What does a perspective projection represent?

(2) What is a visual ray?

(3) How is a perspective projection formed?

(4) How does a perspective projection differ from an orthographic projection?

(5) What is the plane called on which the perspective projection is made?

(6) What is meant by the term Station Point?

(7) What is the most important phenomenon of perspective

(8) What is meant by a system of lines?

(9) What is meant by a system of planes?

(10) What is a visual element?

(11) Define vanishing point.

(12) Define vanishing trace.

(13) Describe the position of the vanishing point of any system of lines.

(14) Give the five axioms of perspective.

(15) Do parallel lines in space really converge?

(16) Do the perspective projections of parallel lines really converge?

(17) Where will the perspective projections of parallel lines meet?

(18) How is the perspective of any point found?

(19) How is the perspective of the vanishing point of any system of lines found?

(20) What will be the perspective of a straight line?

(21) What is meant by the horizon?

(22) What is meant by the plane of the horizon?

THE PLANES OF PROJECTION.

26. Two planes of projection at right angles to one another, one vertical and the other horizontal, are used in making a perspective. In Fig. 7 these two planes are shown in oblique projection. The vertical plane is the picture plane (§ 6 and Fig. 7) on which the perspective projection is made, and corresponds exactly to the vertical plane, or vertical coordinate used in orthographic projections.

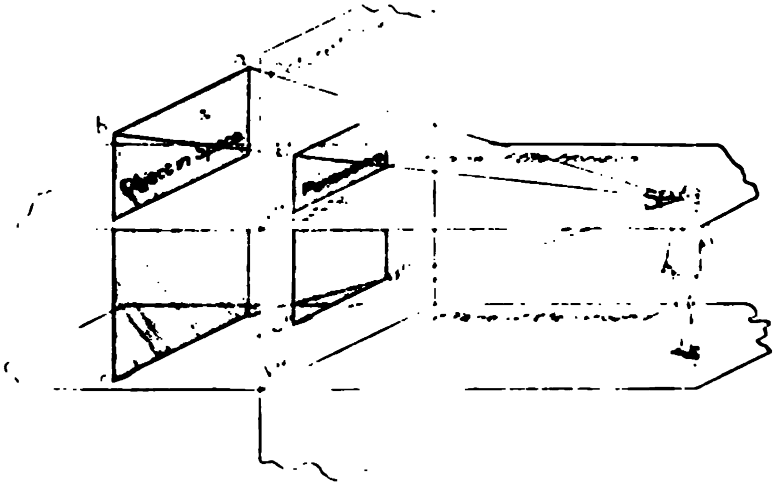


Fig 7. Diagram Showing Planes of Projection

27. The horizontal plane, or plane of the horizon (§ 20 and Fig. 7), *always passes through the assumed position of the observer's eye*, and corresponds exactly to the horizontal plane or horizontal coordinate used in orthographic projections.

28. All points, lines, surfaces, or solids in space, the perspective projections of which are to be found, are represented by their orthographic projections on these two planes, and their perspectives are determined from these projections.

29. Besides these two principal planes of projection, a third plane is used to represent the plane on which the object is supposed to rest (Fig. 7). This third plane is horizontal, and is called the plane of the ground. Its relation to the plane of the horizon determines the nature of the perspective projection. To illustrate: The observer's eye must *always* be in the plane of the horizon (§ 27), while the object, the perspective of which is to be made, is usually supposed to rest upon the plane of the ground. In most cases the plane of the ground will also be the plane on which the observer is supposed to stand, but this will not always be true. The observer may be standing at a much higher level than the plane on which the object rests, or he may be standing below that plane. It is evident, therefore, that if the plane of the ground is chosen far below the plane of the horizon, the observer's eye will be far above the object, and the resulting perspective projection will be a "bird's-eye view." If, on the other hand, the plane of the ground is chosen above the plane of the horizon, the observer's eye will be below the object, and the resulting perspective projection will show the object as though being viewed from below. This has sometimes been called a "worm's-eye view," or a "toad's-eye view."

Usually the plane of the ground is chosen so that the distance between it and the plane of the horizon is about equal (at the scale of the drawing) to the height of a man. This is the position indicated in Fig. 7, and the resulting perspective will show the object as though seen by a man standing on the plane on which the object rests.

30. The intersection of the *picture plane* and the *plane of the horizon* corresponds to the *ground line* used in the study of projections, in Mechanical Drawing. For more advanced work, how-

ever, there is some objection to this term. The intersection of the two coordinate planes has really no connection with the ground, and if the term "ground line" is used, it is apt to result in a confusion between the intersection of the two coordinate planes, and the intersection of the auxiliary plane of the ground, with the picture plane.

31. The intersection of the two coordinate planes is usually lettered VH on the picture plane, and HPP on the plane of the horizon. (See Fig. 7.) That is to say: When the vertical plane is being considered, VH represents the intersection of that plane with the plane of the horizon. It should also be considered as the *vertical projection of the plane of the horizon*. See Mechanical Drawing Part III, paragraph in italics. All points, lines, or surfaces lying in the plane of the horizon will have their *vertical projection* in VH.

32. On the other hand, when the horizontal plane is being considered, HPP represents the intersection of the two planes, and also the *horizontal projection of the picture plane*. All points, lines, or surfaces in the picture plane will have their *horizontal projections* in HPP. Thus, instead of considering the intersection of the two coordinate planes a single line, it should be considered the coincidence of two lines, i.e.: First, the vertical projection of the plane of the horizon; second, the horizontal projection of the picture plane.

33. The plane of the ground is always represented by its intersection with the picture plane (see VH$_1$ Fig. 7). Its only use is to determine the relation between the plane of the horizon and the plane on which the object rests (§ 29). The true distance between these two planes is always shown by the distance between VH and VH$_1$ as drawn on the picture plane.

34. To find the perspective of a point determined by its vertical and horizontal projections.

Fig. 8 is an oblique projection showing the two coordinate planes at right angles to each other. The assumed position of the plane of the ground is indicated by its **vertical trace** (VH$_1$).

NOTE. — The *vertical trace* of any plane is the intersection of that plane with the vertical coordinate. The *horizontal trace* of any plane is the intersection of that plane with the horizontal coordinate.

The assumed position of the station point is indicated by its two projections, SP^V and SP^H. Since the station point lies in the plane of the horizon (§ 27), it is evident that its true position must coincide with SP^H, and that (§ 31) its vertical projection must be found in VH, as indicated in the figure. Let the point a represent any point in space. The perspective of the point a will be at a^P, where a visual ray through the point a pierces the picture plane (§ 24). We may find a^P in the following manner, by using the orthographic projections of the point a^P, instead of the point itself. a^H represents the *horizontal projection*, and a^V represents the *vertical projection* of the point a. A line drawn from the *vertical projection* of the point a to the *vertical projection* of the station point, will represent the *vertical projection of the visual ray*, which passes through the point a. In Fig. 8 this vertical projection is represented by the line drawn on the picture plane from a^V to SP^V.

A line drawn from the *horizontal projection* of a to the *horizontal projection* of the station point will represent the *horizontal projection of the visual ray*, which passes through the point a. In Fig. 8, this horizontal projection is represented by the line drawn on the plane of the horizon from a^H to SP^H. Thus we have, drawn upon the planes of projection, the vertical and horizontal projections of the point a, and the vertical and horizontal projections of the visual ray passing between the point a and the station point.

35. We must now find the intersection of the visual ray with the picture plane. This intersection will be a point in the picture plane. It is evident that its vertical projection must coincide with the intersection itself, and that its horizontal projection must be in HPP (§ 32). But this intersection must also be on the visual ray through the point a, and consequently the horizontal projection of this intersection must be on the horizontal projection of the visual ray. Therefore, the horizontal projection of this intersection must be the point m^H, where the line between

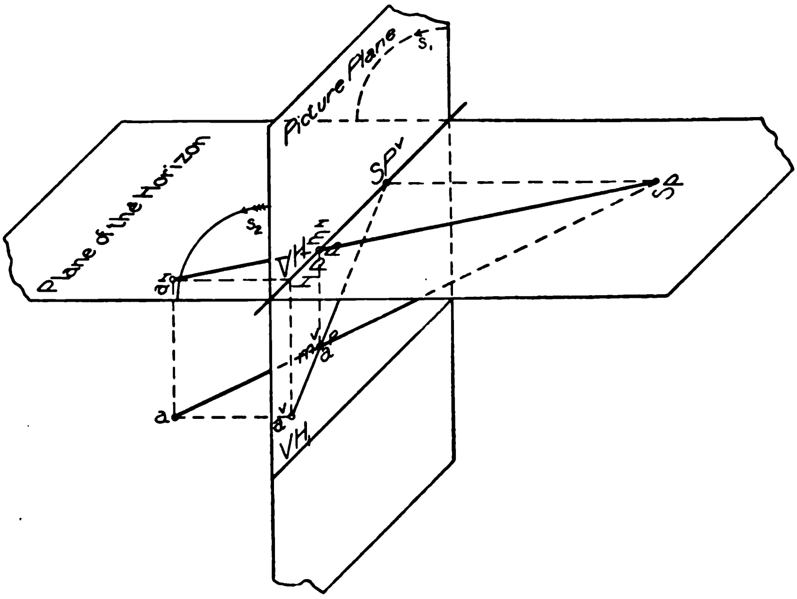


Fig. 8. Diagram Showing Difficulties of Working on Planes at Right Angles

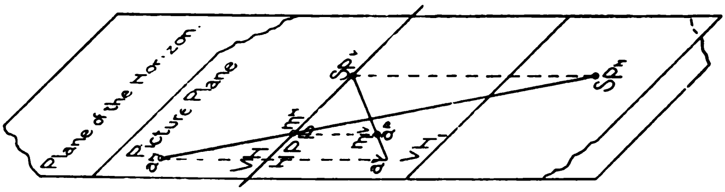


Fig. 9. Diagram Showing Plane of Horizon and Picture Plane Superposed

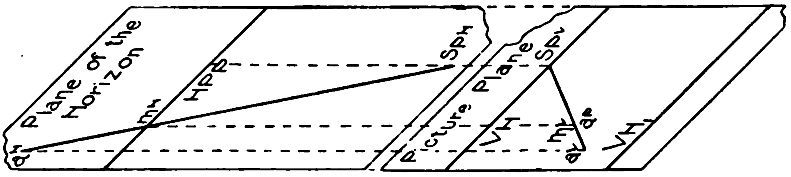


Fig. 9a. Diagram Corresponding to Fig. 9 but with Plane of Horizon and Picture Plane Pulled Apart to Facilitate Examination of Sketches

SP^{H} and a^{H} crosses HPP. The vertical projection of this intersection must be vertically in line with this point, and on the line drawn between SP^{V} and a^{V}, and hence at m^{V}. Since the vertical projection of the intersection coincides with the intersection itself, a^{P} (coincident with m^{V}) must be the perspective of the point a.

36. This is the method of finding the perspective of any point, having given the vertical and horizontal projections of the point and of the station point. The method may be stated briefly as follows: —

Draw through the horizontal projection of the point and the horizontal projection of the station point, a line representing the horizontal projection of the visual ray, which passes through the point. Through the intersection of this line with HPP, draw a vertical line. The perspective of the point will be found where this vertical line crosses the vertical projection of the visual ray, drawn through SP^{V} and a^{V}.

37. It would evidently be inconvenient to work upon two planes at right angles to one another, as shown in Fig. 8. To avoid this, and to make it possible to work upon a plane surface, the picture plane (or vertical coordinate) is supposed to be revolved about its intersection with the plane of the horizon, until the two coincide and form one surface. The direction of this revolution is indicated by the arrows s_1 and s_2. After revolution, the two coordinate planes will coincide, and the vertical and horizontal projections overlap one another, as indicated in Fig. 9.

It will be noticed that the coincidence of the two planes in no way interferes with the method given in § 36, of finding the perspective (a^{P}) of the point a, from the vertical and horizontal projections of the point. Thus, the horizontal projection of the visual ray through the point will be seen, drawn from SP^{H} to a^{H}, and intersecting HPP in the point m^{H}. The vertical projection of the visual ray through the point will be seen passing from SP^{V} to a^{V}. And a^{P} is found upon the vertical projection of the visual ray, directly under m^{H}.

It will readily be understood that in a complicated problem, the overlapping of the vertical and horizontal projections might result in some confusion. It is, therefore, usually customary, after having revolved the two coordinate planes into the position shown in Fig. 9, to slide them apart in a direction *perpendicular to their line of intersection*, until the two planes occupy a position similar to that shown in Fig. 9a.

38. It will be remembered from the course on projections which the student is supposed to have taken, that *horizontal projections must always be compared with horizontal, and never with vertical projections*, and that in the same way, *vertical projections must always be compared with vertical, and never with horizontal projections*. It is evident that in sliding the planes apart, the relations between the projections on the vertical plane will not be disturbed, nor will the relations between the projections on the horizontal plane, and consequently it will make no difference how far apart the two coordinate planes are drawn, provided that horizontal and vertical projections of the same points are always kept in line. Thus, in Fig. 9a, it will be seen that in drawing the planes apart, a^V has been kept in line with a^H, m^V with m^H, SP^V with SP^H, etc.

39. It will be observed that in sliding the planes apart, their line of intersection has been separated into its two projections (§§ 31 and 32). HPP, being on the plane of the horizon or horizontal coordinate, is the *horizontal projection of the intersection* of the two planes, while VH, being on the picture plane or vertical coordinate, is the *vertical projection of the intersection* of the two planes. In the original position of the planes (Fig. 9) these two projections were coincident. The distance between HPP and VH always represents the distance through which the planes have been slid. This distance is immaterial, and will have *no effect* on the perspective drawing. VH_1 represents the vertical trace of the plane of the ground.

In this figure, as in the case of Fig. 9, the student should follow through the construction of the perspective of the point *a*, applying the method of § 36.

40. Fig. 10 shows the position of the two coordinate planes and of the plane of the ground, as they are usually represented on the drawing board in making a perspective drawing. It is essentially the same thing as Fig. 9a, except that the latter was

shown in oblique projection in order that its development from the original position of the planes (Fig. 8) might be followed more readily. The two coordinate planes are supposed to lie in the plane of the paper.

HPP represents the horizontal projection of the picture plane, and VH represents the vertical projection of the plane of the horizon.

As horizontal projections are never compared with vertical projections (§ 38), HPP may be drawn as far from, or as near, VH as desired, without in any way affecting the resulting perspective drawing. HPP and VH were coincident in Fig. 9, and the distance between them in Fig. 10 simply shows the distance that the two planes have been slid apart, as illustrated in Fig. 9a. As already stated, this distance is immaterial, and may be made whatever is most convenient, according to the nature of the problem.

If HPP should be placed nearer the top of the sheet, a^H and SP^H, both being horizontal projections, would follow it, the relation between these horizontal projections always being preserved.

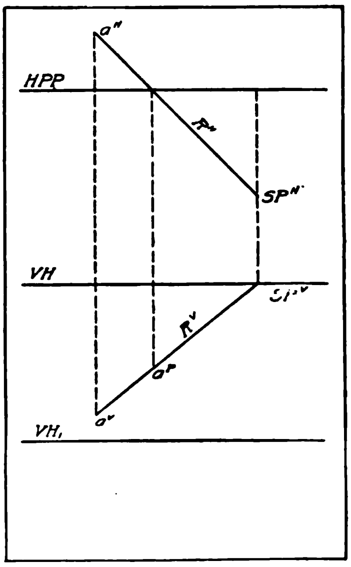


Fig. 10. Simple Sketch Showing Position of Figures in Standard Projection Drawing

On the other hand, SP^V, a^V, a^P, VH, and VH_1, all being projections on the vertical plane, must preserve their relation with one another, and will in no way be affected if the group of projections on the horizontal coordinate is moved nearer or farther away. It must be borne in mind, however, that, in all cases, the vertical and horizontal projections of corresponding points must be kept vertically in line. Thus, a^H must always be vertically in line with a^V. The vertical distance between these two projections does not matter, provided the distance from a^H to HPP, or the distance from a^V to VH, is not changed. This point cannot be too strongly emphasized.

41. Suppose it is desired to determine from Fig. 10 how far the station point lies in front of the picture plane. This is a horizontal distance, and therefore will be shown by the distance between the horizontal projection of the station point and the horizontal projection of the picture plane, or, in other words, by the distance between SP^H and HPP.

42. The point *a* is a certain distance above or below the plane of the horizon. This is a *vertical distance*, and will be shown by the distance between the *vertical projection* of the point *a* and the *vertical projection* of the plane of the horizon; in other words, by the distance between a^V and VH. It will be seen that in Fig. 10 the point *a* lies below the plane of the horizon.

43. If it be desired to find how far in front or behind the picture plane the point *a* lies, this is a *horizontal distance*, and will be shown by the distance between the *horizontal projection* of the picture plane and *horizontal projection* of the point *a*, that is, by the distance between HPP and a^H. In Fig. 10 the point *a* lies behind the picture plane.

44. The distance between the plane of the ground and the plane of the horizon is a vertical distance, and will be shown by the distance between the vertical projection of the plane of the horizon and the vertical projection of the plane of the ground; i.e., the distance between VH and VH_1. The distance between the observer's eye and the plane of the ground is also a vertical distance, and will be shown by the distance between SP^V and VH_1; but as SP^V must always be found in VH, the distance of the observer's eye above the plane of the ground will always be shown by the distance between VH and VH_1.

45. To find the perspective of the point *a*, Fig. 10, draw the visual ray through the point, and find where this visual ray pierces the picture plane (§ 24 *f*). The horizontal projection of the visual ray is shown by the line R^H drawn through the horizontal projection SP^H of the observer's eye and the horizontal projection a^H of the point *a*. The vertical projection of the visual ray is shown by the line R^V drawn through the vertical projection SP^V of the observer's eye and the vertical projection a^V of the point *a*. This visual ray pierces the picture plane at the point a^P on R^V vertically in line with the point where

R^H crosses HPP (§§ 35 and 36). a^P is the perspective of the point a.

NOTE. — To find where any line, represented by its horizontal and vertical projections, pierces the picture plane, is one of the most used and most important problems in perspective projection. The point where any line pierces the picture plane will always be found on the vertical projection of the line, vertically above or below the point where the horizontal projection of the line crosses HPP (§§ 35 and 36).

NOTATION.

46. In order to avoid confusion between the vertical, horizontal, and perspective projections of the points and lines in the drawing, it becomes necessary to adopt some systematic method of lettering the different points and lines. The following method will be found convenient, and has been adopted in these notes.

If the student will letter each point or line as it is found, in accordance with this notation, he will be able to read his drawings at a glance, and any desired projection of a point or line may be recognized instantly.

The *picture plane* (or vertical coordinate) is indicated by the capital letters PP.

The *plane of the horizon* (or horizontal coordinate) is indicated by the capital letter H.

A *point* in space is indicated by a small letter.

The same small letter with an index ^{V}, ^{H}, or ^{P}, indicates its *vertical*, *horizontal*, or *perspective projection*, respectively.

A *line* in space is indicated by a capital letter, usually one of the first letters in the alphabet.

The same capital letter with an index ^{V}, ^{H}, or ^{P}, indicates its *vertical*, *horizontal*, or *perspective projection*, respectively.

All lines which belong to the same system may be designated by the same letter, the different lines being distinguished by the subordinate $_1$, $_2$, $_3$, etc., placed after the letter.

The *trace of a plane upon the picture plane* is indicated by a capital letter (usually one of the last letters in the alphabet) with a capital V placed before it.

The same letter preceded by a capital H *indicates the trace of the plane upon the horizontal coordinate.*

The *perspective of the vanishing trace of a system of planes* is indicated by a capital letter preceded by a capital T.

The *perspective of the vanishing point of a system of lines* is indicated by a small r with an index corresponding to the letter of the lines which belong to the system.

PP = vertical coordinate, or picture plane.

HPP = horizontal trace of the vertical coordinate, or picture plane.

H = horizontal coordinate, or plane of the horizon.

VH = vertical trace of the horizontal coordinate, or plane of the horizon.

H_1 = plane of the ground.

VH_1 = vertical trace of the plane of the ground.

a = point in space.

a^V = vertical projection of the point.

a^H = horizontal projection of the point.

a^P = perspective projection of the point.

A = line in space.

A^V = vertical projection of the line.

A^P = perspective projection of the line.

VS = trace of the plane S upon PP (vertical trace).

HS = trace of the plane S upon H (horizontal trace).

TS = perspective of the vanishing trace of the plane S. (See Note 1 below.)

r^A = perspective of the vanishing point of a system of lines, the elements of which are lettered A_1, A_2, A_3, A_4, etc. (See Note 2 below.)

NOTE 1. — A plane in space may also be designated by the letters of any two lines which lie in it. Thus, the plane AB would be a plane determined by the two lines A and B. TAB would indicate the perspective of the vanishing trace of the plane.

NOTE 2. — A straight line may be designated by the letters of any two points which lie in it. Thus, the line ab would be a straight line determined by the two points a and b. r^{ab} would indicate the perspective of the vanishing point of the line. It is sometimes convenient to use this notation in place of the general one.

ELEMENTARY PROBLEMS.

47. PROBLEM I. Fig. 11. **To find the perspective of a point. The point to be situated ¼″ behind the picture plane, and ⅛″ above the plane of the horizon. The observer's eye to be ½″ in front of the picture plane.**

First assume HPP and VH (§ 40). These lines may be drawn anywhere on the paper, HPP usually being placed some distance above VH, in order to avoid confusion between horizontal and vertical projections. The position of the point with respect to the coordinate planes must now be established by means of its vertical and horizontal projections. a^V located ⅛″ above VH will represent the vertical projection of the point. Its horizontal projection must be vertically in line with a^V; and since the point is to be ¼″ behind the picture plane, its horizontal projection must be ¼″ behind the horizontal projection of the picture plane, i.e., ¼″ behind HPP. Next establish the position of the observer's eye, or station point. Its vertical projection (SP^V) may be assumed anywhere in VH. Its horizontal projection (SP^H) must be vertically in line with SP^V and ½″ in front of HPP. The perspective of the point *a* will be where the visual ray through the point pierces the picture plane. A line R^H drawn through SP^H and a^H will be the horizontal projection of this visual ray. Its vertical projection will be the line R^V drawn through SP^V and a^V. The perspective a^P of the point will be found on R^V vertically in line with the intersection of R^H and HPP (§ 45, note). Compare with the construction shown in Fig. 10 and Fig 8.

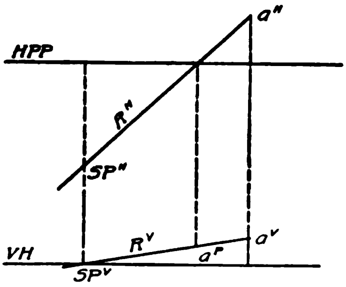


Fig. 11. Diagram for Finding Perspective of a Point

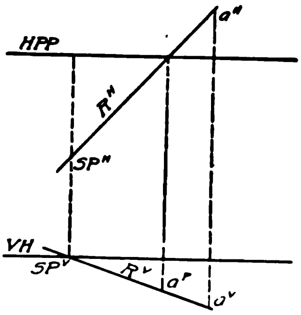


Fig. 12. Projection of a Point. Location Different from Fig. 11

48. Figs. 12, 13, and 14 illustrate this same problem.

In Fig. 12, the point *a*, as shown by its vertical and horizontal projections, is situated ¼″ *below* the plane of the horizon and ¼″ *behind* the picture plane. a^P is the perspective of the point.

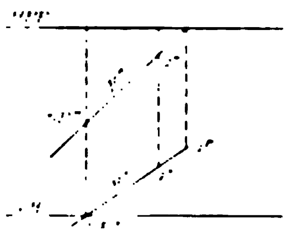


Fig 13 Projection of a Point. Location Different from Fig 11

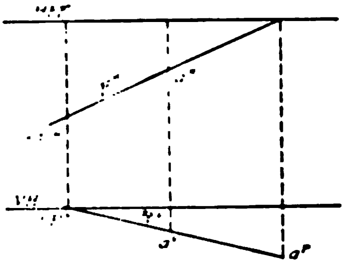


Fig 14. Projection of a Point. Location Different from Fig. 11

In Fig. 13, the point *a* is ¼″ *above* the plane of the horizon and ¼″ *in front* of the picture plane. a^P is its perspective.

In Fig. 14, the point *a* is ¼″ *below* the plane of the horizon and ¼″ *in front* of the picture plane. a^P is its perspective.

49. PROBLEM II. Fig. 15. **To find the perspective of a line, the line being determined by its vertical and horizontal projections.**

Let HPP and VH be given as indicated in the figure. Let A^H represent the horizontal projection of the line, its two extremities being represented by a^H and b^H, respectively. Similarly, let A^V be the vertical projection of the line, a^V and b^V being the vertical projections of its extremities. Let the position of the observer's eye be as indicated by SP^V and SP^H.

The perspective of the point *a* has been found by Problem I. at a^P. The perspective of the point *b* has been found by Problem I. at b^P. The line (A^P), joining a^P and b^P, will be the perspective of the given line. (See note under § 23.)

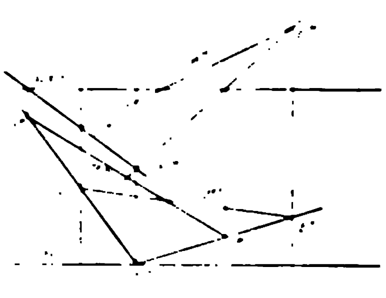


Fig 15. Perspective Drawing for Locating a Line

50. PROBLEM III. Fig. 16. Having given the vertical and horizontal projection of any line, to find the perspective of its vanishing point.

Let the line be given by its vertical and horizontal projections (A^V and A^H), as indicated in the figure. SP^V and SP^H represent the position of the observer's eye. To find the perspective of the vanishing point of any line, draw through the observer's eye an element of the system to which the line belongs, and find where this element pierces the picture plane (§ 24 *g*). Through SP^H draw A_1^H parallel to AH, and through SP^V draw A_1^V parallel to A^V. A_1^H and A_1^V represent the two projections of a line passing through the observer's eye and parallel to A^HA^V. This line pierces the picture plane at v^A, giving the perspective of the required vanishing point (§ 45, note). The perspectives of all lines parallel to A^VA^H will meet at v^A.

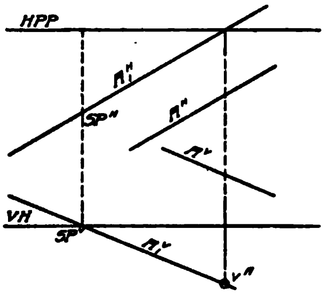


Fig. 16. Diagram for Locating Perspective of Vanishing Point of a Line

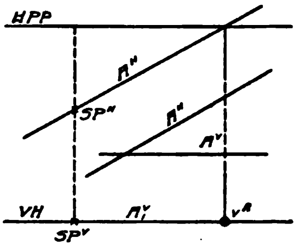


Fig. 17. Diagram Similar to Fig. 16 Showing Projections of a Horizontal Line

Figs. 17 and 18 illustrate this same problem.

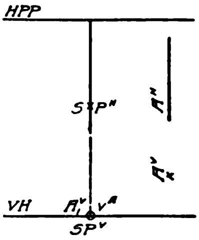


Fig. 18. Diagram for Problem Similar to Fig. 16

51. In Fig. 17, the line, as shown by its two projections, is a horizontal one; hence, A_1^V drawn through SP^V coincides with VH, and the vanishing point for the system of the lines must be found on VH at v^A, as indicated (§ 24 *c*).

NOTE.—Systems of lines which vanish upward will have their vanishing points above VH. Systems of lines which vanish downward will have their vanishing points below VH (§ 16).

52. In Fig. 18, the given line is perpendicular to the picture plane; hence, A_1^v must be a point coincident with SP^v; and as v^A will always be found on A_1^v, the vanishing point of the line must coincide with SP^v.

NOTE. — In a perspective drawing, the vanishing point for a system of lines perpendicular to the picture plane will always coincide with the vertical projection of the observer's eye.

METHOD OF THE REVOLVED PLAN.

53. PROBLEM IV. Fig. 19. **To find the perspective of a rectangular block resting upon a horizontal plane 1″ below the level of the eye, and turned so that the long side of the block makes an angle of 30° with the picture plane.**

The block is shown in plan and elevation at the left of the figure. The first step will be to make an auxiliary horizontal projection of the block on the plane of the horizon, showing the exact position of the block as it is to be seen in the perspective projection. This auxiliary horizontal projection is really a revolved plan of the object, and is called a **Diagram.** It is the general rule, in making a perspective projection, to place the object behind the picture plane with one of its principal vertical lines lying in the picture plane (24 *h*). HPP is usually drawn near the upper edge of the paper, leaving just room enough behind to place the auxiliary plan or diagram. In the figure the diagram is shown in the required position, i.e., with one of its long sides (*abfe*) making an angle of 30° with the picture plane. The vertical edge (*ae*) of the block is supposed to lie in the picture plane. VH may now be drawn parallel to HPP at any convenient distance from it, as indicated. VH_1, the vertical trace of the plane on which the block is supposed to rest, should be assumed in accordance with the given data, i.e., 1″ below VH (§ 44).

The position of the observer's eye should next be established. SP^H is its horizontal projection, and shows by its distance from HPP the distance in front of the picture plane at which the observer is supposed to stand. SP^v is its vertical projection, and must always be found in VH. In this problem the station point is $1\frac{1}{2}''$ in front of the picture plane.

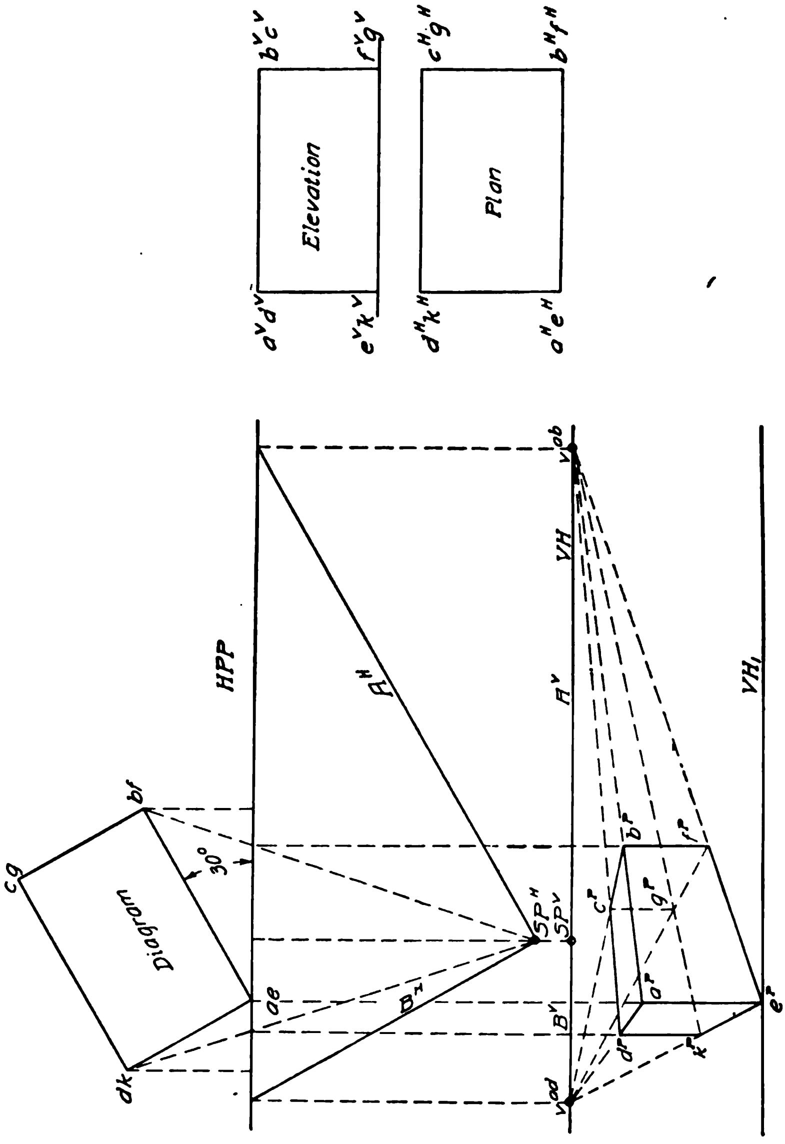


Fig. 19. Diagram for Finding Perspective of a Rectangular Block Resting on Horizontal Plane. Long Side of Block Makes Angle of 30 Degrees with a Picture Plane

Note. — As a general rule, it is well to assume the station point on a vertical line half way between two lines dropped from the extreme edges of the diagram, as indicated. This is not necessary, but, as will be explained later, it usually insures a more pleasing perspective projection.

Next find the vanishing points for the different systems of lines in the object (§ 12). There are three systems of lines in the block, formed by its three sets of parallel edges.

1st. A system formed by the four horizontal edges vanishing to the right: *ab*, *ef*, *dc*, and *kg*.

2d. A system formed by the four horizontal edges vanishing towards the left: *ad*, *ek*, *bc*, and *fg*.

3d. A system formed by the four vertical edges.

First find the vanishing point for the system parallel to *ab* by drawing through the station point a line parallel to *ab* and finding where it pierces the picture plane (24 *g*). A^H drawn through SP^H is the horizontal projection of such a line. Its vertical projection (A^V), drawn through SP^V, will coincide with VH, and its vanishing point will be found on VH at v^{ab} (§ 51). All lines in the perspective of the object that are parallel to *ab* will meet at v^{ab} (§ 24 *a*). In a similar manner find v^{ad}, which will be the vanishing point for all lines parallel to *ad*.

54. If the method for finding any vanishing point is applied to the system of vertical lines, it will be found that this vanishing point will lie vertically over SP^V at infinity. That is to say, since all vertical lines are parallel to the picture plane, if a vertical line is drawn through the station point, it will never pierce the picture plane. Therefore (24 *g*), the perspective of the vanishing point of a vertical line cannot be found within any finite limits, but will be *vertically over SP^V, and at an infinite distance from it.* In a perspective projection *all vertical lines are drawn actually vertical, and not converging towards one another.*

Note. — This is true of all lines in an object which are *parallel to the picture plane.* Thus, *the perspective of any line which is parallel to the picture plane, will actually be parallel to the line itself;* and *the perspectives of the elements of a system of lines parallel to the picture plane, will be drawn parallel to, and not converging towards, one another.* That this must be so, is evident, since, if the perspectives of such a system of lines did converge towards one another, they would meet within finite limits. But it has just been found that the perspective of the vanishing point of such a system is at infinity. The perspectives of the elements of any system can meet only at the perspective of their vanishing point, and must, therefore, in a system parallel to the picture plane, be drawn parallel to one another.

The directions of the perspectives of all lines in the object have now been determined, and will be as follows:

All lines parallel to ab will meet at v^{ab}.
All lines parallel to ad will meet at v^{ad}.
All vertical lines will be drawn vertical.

Since the point e is in the base of the object, it lies on the plane of the ground, and also, since the line ae lies in the picture plane, the point e must lie on the intersection of the plane of the ground with the picture plane. Therefore, the point e must lie in VH_1, and must be vertically under the point e in the diagram. Since the point e lies in the picture plane, it will be its own perspective; and e^P will be found on VH_1, vertically under e in the diagram, as shown in the figure. From e^P the perspective of the lower edges of the cube will vanish at v^{ab} and v^{ad}, respectively, as indicated.

f^P is the perspective of the point f, and will be found on the lower edge of the block, vertically under the intersection of HPP with the horizontal projection of the visual ray drawn through the point f in the diagram.

Similarly, k^P is found on the lower edge of the block, vertically under the intersection of HPP and the visual ray drawn through the point k in the diagram.

Vertical lines drawn through f^P, e^P, and k^P, will represent the perspectives of the visible vertical edges of the block.

The edge e^Pa^P being in the picture plane will be its own perspective, and show in its true size (§ 24 h). Therefore, a^P may be established by making the distance e^Pa^P equal to e^Va^V as taken from the given elevation. From a^P two of the upper horizontal edges of the block will vanish at v^{ab} and v^{ad}, respectively, establishing the points b^P and d^P, by their intersections with the vertical edges drawn through k^P and f^P, respectively. Lines drawn through

a^P and b^P, and vanishing respectively at v^{ab} and v^{ad}, will intersect at c^P, and complete the perspective of the block.

Before going farther in the notes, the student should solve the problems on Plate I.

LINES OF MEASURES.

55. Any line which lies in the picture plane will be its own perspective, and show the true length of the line (24 *h*). Such a line is called a **Line of Measures.**

In the last problem, the line *ac*, being in the picture plane, was a line of measures; that is to say, its length could be laid off directly from the given data, and from this length the lengths of the remaining lines in the perspective drawing could be established. Fig. 20 shows a similar problem. The line *ac* lies in the picture plane, and a^Pc^P is, therefore, a line of measures for the object.

56. Besides this principal line of measures, other lines of measures may easily be established by extending any vertical plane in the object until it intersects the picture plane. This intersection, since it lies in the picture plane, will show in its true size, and will be an **auxiliary line of measures.** All points in it will show at their true height above the plane of the ground. Thus, in Fig. 20, a^Pc^P is the principal line of measures, and shows the true height of the block. If the rear vertical faces of the block are extended till they intersect the picture plane, these intersections (m^Pn^P and o^Pp^P) will be auxiliary lines of measures, and will also show the true height of the block. It will be noticed in the figure that m^Pn^P and o^Pp^P are each equal to a^Pc^P. Either one of these lines could have been used to determine the vertical height of the perspective of the block. For illustration, suppose it is desired to find the height of the perspective, using the line o^Pp^P as the line of measures. Assume the vanishing points (v^{ad} and v^{ab}) for the two systems of horizontal edges in the block to have been established as in the previous case. Now extend the line *bc* (in the diagram), which represents the horizontal projection of the face *cgf*, till it intersects HPP. From this intersection drop a vertical line *op* which will represent the intersection of the vertical face *cgf* with the picture plane, and will be a line of measures for the face. p^P, where this line of measures intersects VH_1, will be the

point where the lower horizontal edge (produced) of the face cbf intersects the picture plane. Measure off the distance p^Po^P equal to the true height of the block, as given by the elevation. Two lines drawn through o^P and p^P respectively, and vanishing at v^{ad}, will represent the perspectives of the upper and lower edges of the face cbf, produced. The perspective (b^P), of the point b, will be found on the perspective of the upper edge of the face cbf, vertically below the intersection of HPP with the horizontal projection of a visual ray drawn through the point b in the diagram. A vertical line through b^P will intersect the lower horizontal edge of the face cbf in the point f^P. Lines drawn respectively through b^P and f^P, vanishing at v^{ab}, will establish the perspectives of the upper and lower horizontal edges of the face $abfe$ The points a^P and e^P will be found vertically under the points a and e in the diagram. The remainder of the perspective projection may now easily be determined.

57. The perspectives of any points on the faces of the block may be found by means of the diagram and one of the lines of measures.

Let the points g^V, h^V, k^V, and l^V, in the given elevation, determine a square on the face $abfe$ of the block. Let the points g, h, k, and l, represent the position of the square in the diagram. Extend the upper and lower horizontal edges of the square, as shown in elevation, until they intersect the vertical edge a^Ve^V in the points t^V and v^V. To determine the perspective of the square, lay off on a^Pe^P, which is a line of measures for the face $abfe$, the divisions t^P and v^P taken directly from the elevation. Two lines drawn through t^P and v^P respectively, vanishing at v^{ab}, will represent the perspectives of the upper and lower edges (produced) of the square. g^P will be found on the perspective of the upper edge, vertically under the intersection of HPP with the horizontal projection of a visual ray drawn through the point g in the diagram. The position of k^P may be established in a similar manner. Vertical lines drawn through g^P and k^P respectively, will complete the perspective of the square.

58. The auxiliary line of measures o^Pp^P might have been used instead of a^Pe^P. In this case, o^Pp^P should be divided by the points w^P and y^P, in the same way that ae, in elevation, is divided

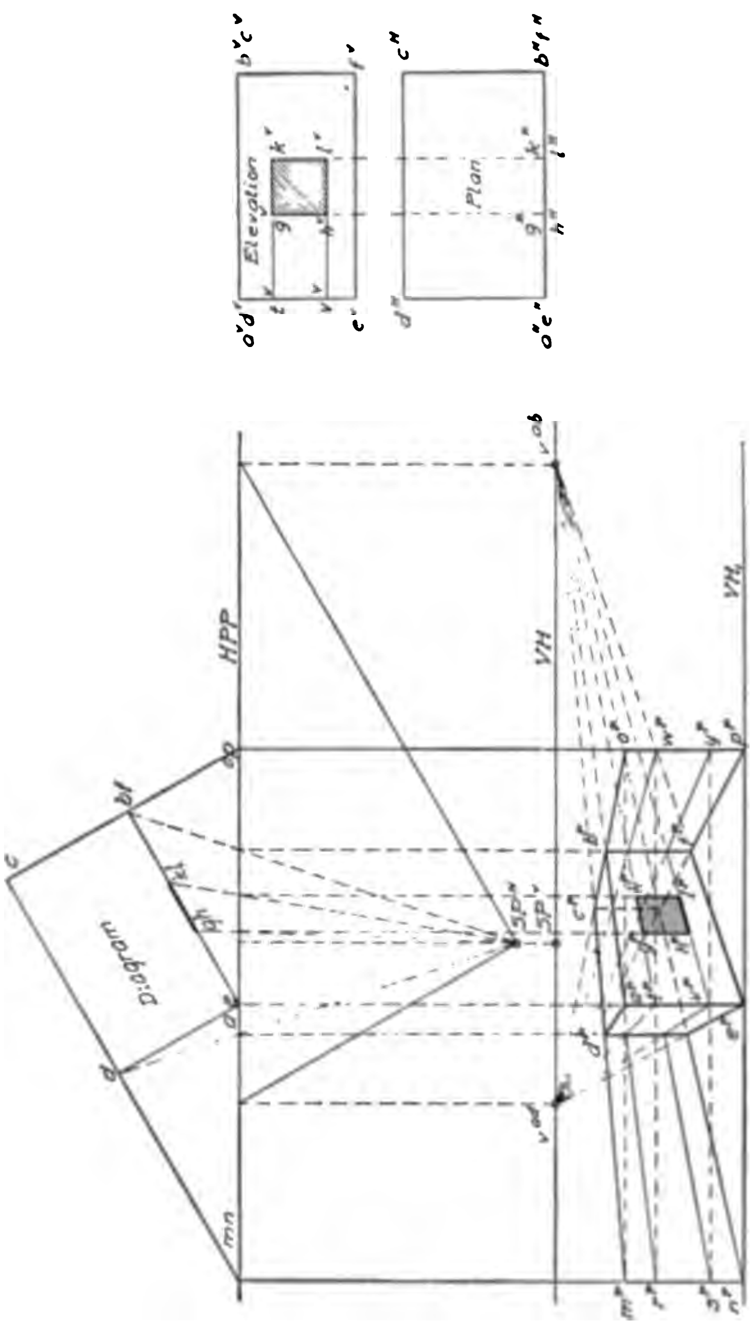


Fig. 20. Diagram of Problem Similar to Fig. 19, Showing Development of Lines of Measure

by the points t and v. Through w^P and y^P, draw horizontal lines lying in the plane cbf, for which o^Pp^P is a line of measures. These lines will vanish at v^{ad}, and intersect the vertical edge b^Pf^P of the block. From these intersections draw horizontal lines lying in the plane $abef$, vanishing at v^{ab}, and representing the upper and lower edges of the square. The remainder of the square may be determined as in the previous case.

In a similar manner, the auxiliary line of measures m^Pn^P might have been used to determine the upper and lower edges of the square. This construction has been indicated, and the student should follow it through.

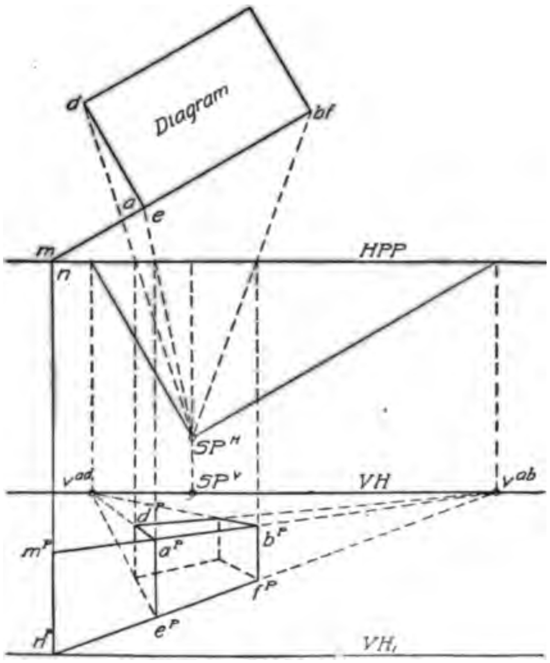


Fig. 21. Diagram Showing Extension of Certain Lines of Object to Form Auxiliary Line of Measure

59. It sometimes happens that no line in the object lies in the picture plane. In such a case there is no principal line of measures, and some vertical plane in the object must be extended until it intersects the picture plane, forming by this intersection an auxiliary line of measures. Fig. 21 illustrates such a case. A rectangular block, similar to those shown in Figs. 19 and 20, is

situated some distance behind the picture plane, as indicated by the relative positions of HPP and the diagram.

Its perspective projection will evidently be smaller than if the vertical edge *ae* were in the picture plane, as was the case in Figs. 19 and 20, and the perspective of *ae* will evidently be shorter than the true length of *ae*. There is, therefore, no line in the object that can be used for a line of measures. It becomes necessary to extend one of the vertical faces of the block until it intersects the picture plane, and shows by the intersection its true vertical height. Thus, the plane *abfe* has been extended, as indicated in the diagram, until it intersects the picture plane in the line *mn*. This intersection is an auxiliary line of measures for the plane *abfe*, and m^Pn^P shows the true vertical height of this plane.

Either of the other vertical faces of the block, as well as the face *abfe*, might have been extended until it intersected the picture plane, and formed by this intersection a line of measures for the block.

The vanishing points for the various systems of lines have been found as in the previous cases.

From m^P and n^P, the horizontal edges of the face *abfe* vanish to v^{ab}. a^P will be found on the upper edge of this face, vertically below the intersection of HPP with the horizontal projection of the visual ray through the point *a* in the diagram. A vertical line through a^P will represent the perspective of the nearest vertical edge of the block, and will establish the position of e^P.

In a similar manner, b^P will be found vertically below the intersection of HPP with the horizontal projection of the visual ray through the point *b* in the diagram. A vertical line through b^P will establish f^P, and complete the perspective of the face *abfe*. Having found the perspective of this face, the remainder of the block may be determined as in the previous problems.

NOTE.—Instead of being some distance behind the picture plane, the block might have been wholly or partly in front of the picture plane. In any case, find the intersection with the picture plane of some vertical face of the block (produced, if necessary). This intersection will show the true vertical height of the block.

At this point the student should solve Plate II.

60. PROBLEM V. Fig. 22. **To find the perspective of a house, the projections of which are given.**

The plan, front, and side elevations of the house are shown in the figure. The side elevation corresponds to the projection on the profile plan, used in the study of projections. This problem is a further illustration of the method of revolved plan and of the use of horizontal vanishing points and auxiliary lines of measures. It is very similar to the three previous problems on the rectangular blocks.

The first step in the construction of the perspective projection is to make a diagram (§ 53) which shall show the horizontal projections of all the features that are to appear in the drawing. The diagram should be placed at the top of the sheet, and turned so that the sides of the house make the desired angles with the picture plane. In Fig. 22 the diagram is shown with the long side making an angle of 30° with the picture plane. The roof lines, the chimney, and the positions of all windows, doors, etc., that are to be visible in the perspective projection, will be seen marked on the diagram.

The nearest vertical edge of the house is to lie in the picture plane. This is indicated by drawing HPP through the corner of the diagram which represents this nearest edge.

VH may be chosen at any convenient distance below HPP.

The position of the station point is shown in the figure by its two projections SP^V and SP^H. SP^V must always be in VH. The distance between SP^H and HPP shows the distance of the observer's eye in front of the picture plane (§ 43).

v^{ab} and v^{ad} may be found as in the preceding problems.

The position of the plane on which the object is to rest should next be established by drawing VH_1, the distance between VH and VH_1 showing the height of the observer's eye above the ground (§ 44).

In addition to the plane of the ground represented by VH_1, a second ground plane, represented by VH_2, has been chosen some distance below VH_1. In the figure, two perspective projections have been found, one resting on each of these two ground planes. The perspective which rests upon the plane represented by VH_1 shows the house as though seen by a man standing with his eyes

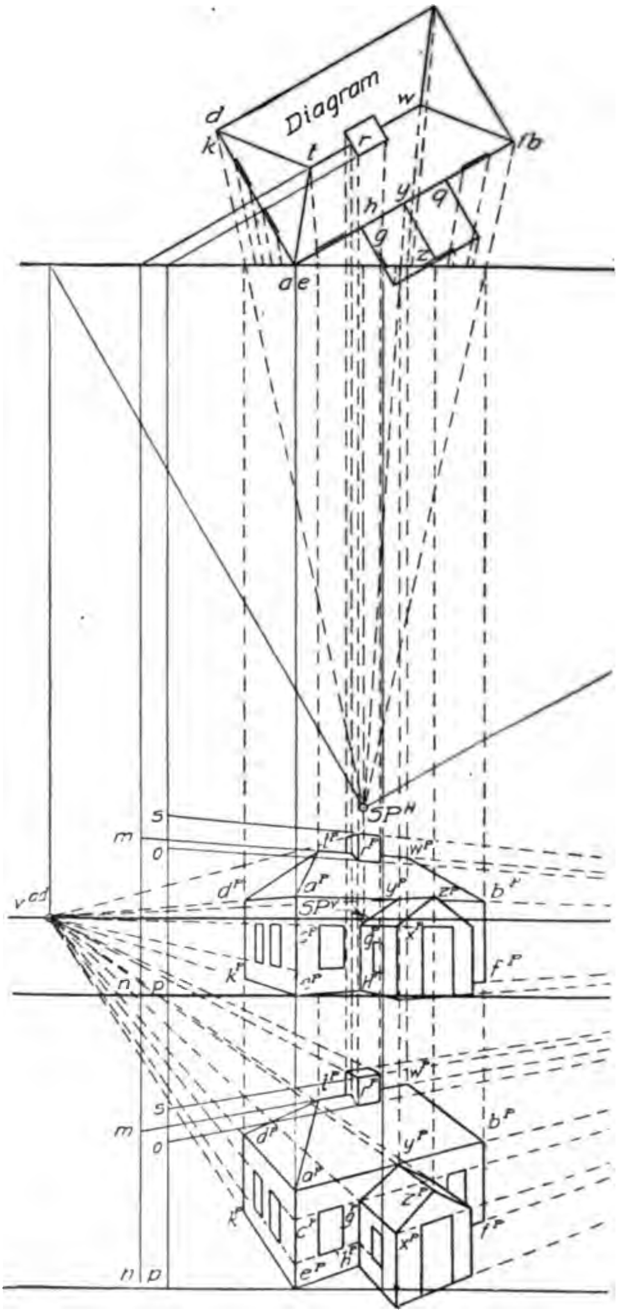
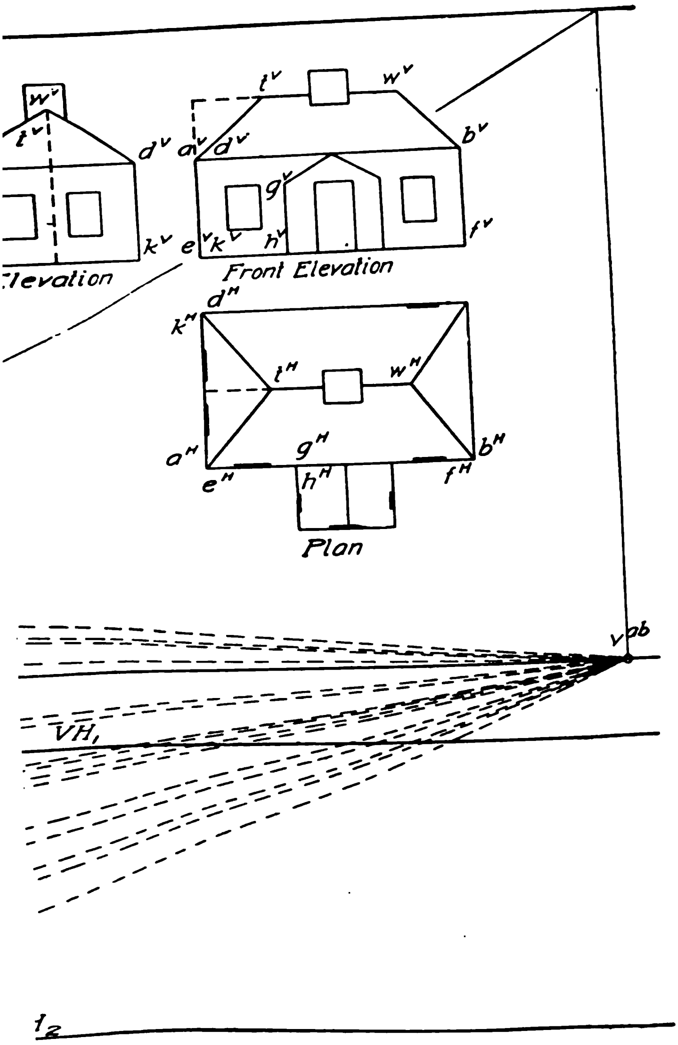


Fig. 22. Diagram Showing Method of Finding



of a House, the Projections of Which Are Given

nearly on a level with the tops of the windows (§ 29). The view which rests on the plane represented by VH_2 shows a bird's-eye view of the house, in which the eye of the observer (always in VH) is at a distance above the plane on which the view rests, equal to about two and one-half times the height of the ridge of the house above the ground.

These two perspective projections illustrate the effect of changing the distance between VH and the vertical trace (§ 34, note) of the plane on which the perspective projection is supposed to rest. The construction of both views is exactly the same. The following explanation applies to both equally well, and the student may consider either in studying the problem.

61. We will first neglect the roof of the house, and of the porch. The remaining portion of the house will be seen to consist of two rectangular blocks, one representing the main body of the house, and the other representing the porch.

The block representing the main part of the house occupies a position exactly similar to that of the block shown in Fig. 19. First consider this block irrespective of the remainder of the house. A vertical line dropped from the corner of the diagram that lies in HPP will be a measure line for the block, and will establish, by its intersection with VH_1 (or VH_2), the position of the point c^P, in exactly the same way that the point c^P in Fig. 19 was established. c^Pa^P shows the true height of the part of the house under consideration, and should be made equal to the corresponding height a^Vc^V, as shown by the elevations. The rectangular block representing the main part of the house may now be drawn exactly as was the block in Fig. 19, Problem IV.

62. Having found the perspective of the main part of the house, the porch (without its roof) may be considered as a second rectangular block, no vertical edge of which lies in the picture plane. It may be treated in a manner exactly similar to that of the block shown in Fig. 21, § 59. We may consider that the *rear* vertical face of the block, which forms the porch of the house q, q, has been extended until it intersects the picture plane in the line ac, giving a line of measures for this face, just as in Fig. 21 the *nearest* vertical face of the block was extended until it intersected the picture plane in the line of measures mn.

nearly on a level with the tops of the windows (§ 29). The view which rests on the plane represented by VH_2 shows a bird's-eye view of the house, in which the eye of the observer (always in VH) is at a distance above the plane on which the view rests, equal to about two and one-half times the height of the ridge of the house above the ground.

These two perspective projections illustrate the effect of changing the distance between VH and the vertical trace (§ 34, note) of the plane on which the perspective projection is supposed to rest. The construction of both views is exactly the same. The following explanation applies to both equally well, and the student may consider either in studying the problem.

61. We will first neglect the roof of the house, and of the porch. The remaining portion of the house will be seen to consist of two rectangular blocks, one representing the main body of the house, and the other representing the porch.

The block representing the main part of the house occupies a position exactly similar to that of the block shown in Fig. 19. First consider this block irrespective of the remainder of the house. A vertical line dropped from the corner of the diagram that lies in HPP will be a measure line for the block, and will establish, by its intersection with VH_1 (or VH_2), the position of the point e^P, in exactly the same way that the point e^P in Fig. 19 was established. e^Pa^P shows the true height of the part of the house under consideration, and should be made equal to the corresponding height a^Ve^V, as shown by the elevations. The rectangular block representing the main part of the house may now be drawn exactly as was the block in Fig. 19, Problem IV.

62. Having found the perspective of the main part of the house, the porch (without its roof) may be considered as a second rectangular block, no vertical edge of which lies in the picture plane. It may be treated in a manner exactly similar to that of the block shown in Fig. 21, § 59. We may consider that the *rear* vertical face of the block, which forms the porch of the house o, q, has been extended until it intersects the picture plane in the line ae, giving a line of measures for this face, just as in Fig. 21 the *nearest* vertical face of the block was extended until it intersected the picture plane in the line of measures mn.

On e^pa^p, make e^pc^p equal to the true height of the vertical wall of the porch, as given by the elevation. A line through c^p, vanishing at v^{ab}, will be the perspective of the upper horizontal edge of the rear face of the block which forms the porch. The line through e^p, vanishing at v^{ab}, which forms the lower edge of the front face of the main body of the house, also forms the lower edge of the rear face of the porch. Through the point h in the diagram, draw a visual ray, and through the intersection of this visual ray with HPP drop a vertical line. Where this vertical line crosses the upper and lower horizontal edges of the rear face of the porch, will establish the points g^p and h^p respectively. Having found the vertical edge g^ph^p, the remainder of the perspective of the porch (except the roof) can be found without difficulty, the horizontal edges of the porch vanishing at either v^{ab} or v^{ad}, according to the system to which they belong. Each vertical edge of the porch will be vertically below the point where HPP is crossed by a visual ray drawn through the point in the diagram which represents that edge. The fact that the porch projects, in part, in front of the picture plane, as indicated by the relation between the positions of the diagram and HPP, makes absolutely no difference in the construction of the perspective projection.

All of the vertical construction lines have not been shown in the figure, as this would have made the drawing too confusing. The student should be sure that he understands how every point in the perspective projection has been obtained, and, if necessary, should complete the vertical construction lines with pencil.

63. Having found the perspective of the vertical walls of the main body of the house, and of the porch, the next step will be to consider the roof of the main part of the house.

Imagine the horizontal line tw, which forms the ridge of the roof, to be extended until it intersects the picture plane. This is shown on the diagram by the extension of the line tw until it intersects HPP. From this intersection drop a vertical line, as indicated in the figure. This vertical line may be considered to be the line of measures for an imaginary vertical plane passing through the ridge of the house, as indicated by the dotted lines in the plan and elevations of the house. On this line of measures, lay off the distance nm measured from VII_1 (or VII_2), equal to the true height of the ridge above the ground as given by the elevations of the house. A line drawn from the point m, vanishing at v^{ab}, will represent the ridge of the house, indefinitely extended. From the points t and w in the diagram draw visual rays. From the intersections of these visual rays with HPP drop vertical lines which will establish the positions of t^P and w^P on the perspective of the ridge of the roof. Lines drawn from t^P and w^P to the corners of the vertical walls of the house, as indicated, will complete the perspective of the roof.

To find the perspective of the porch roof, draw a visual ray through the point y on the diagram, and from its intersection with HPP drop a vertical. Where this vertical crosses the line a^Pb^P will give y^P, one point in the perspective of the ridge of the porch. The perspective of the ridge will be represented by a line through y^P, vanishing at v^{ad}. The point z^P in the ridge will be vertically below the intersection of HPP with the visual ray drawn through the point z on the diagram. Lines drawn from y^P and z^P to the corners of the vertical walls of the porch, as indicated, will complete the perspective of the porch roof.

64. The perspective of the chimney must now be found. It will be seen that the chimney is formed by a rectangular block; and if it is supposed to extend down through the house, and rest upon the ground, it will be a block under exactly the same conditions as the one shown in Fig. 21, § 59. In order to find its perspective, extend its front vertical face, as indicated on the diagram, till it intersects HPP. A vertical line dropped from this intersection will be a line of measures for the front face of the chimney, and the distance ps, laid off on this line from VII_1 (or VII_2), will show the true height of the top of the chimney above the ground, as given on the elevation. The distance so, measured from the point s on the line of measures, will be the true vertical height of the face of the chimney that is visible above the roof. Lines through s and o, vanishing at v^{ab}, will represent the horizontal edges of the front visible face of the chimney. The vertical edges of this face will be found vertically below the points where HPP is crossed by the visual rays drawn through the horizontal projections of these edges on the diagram.

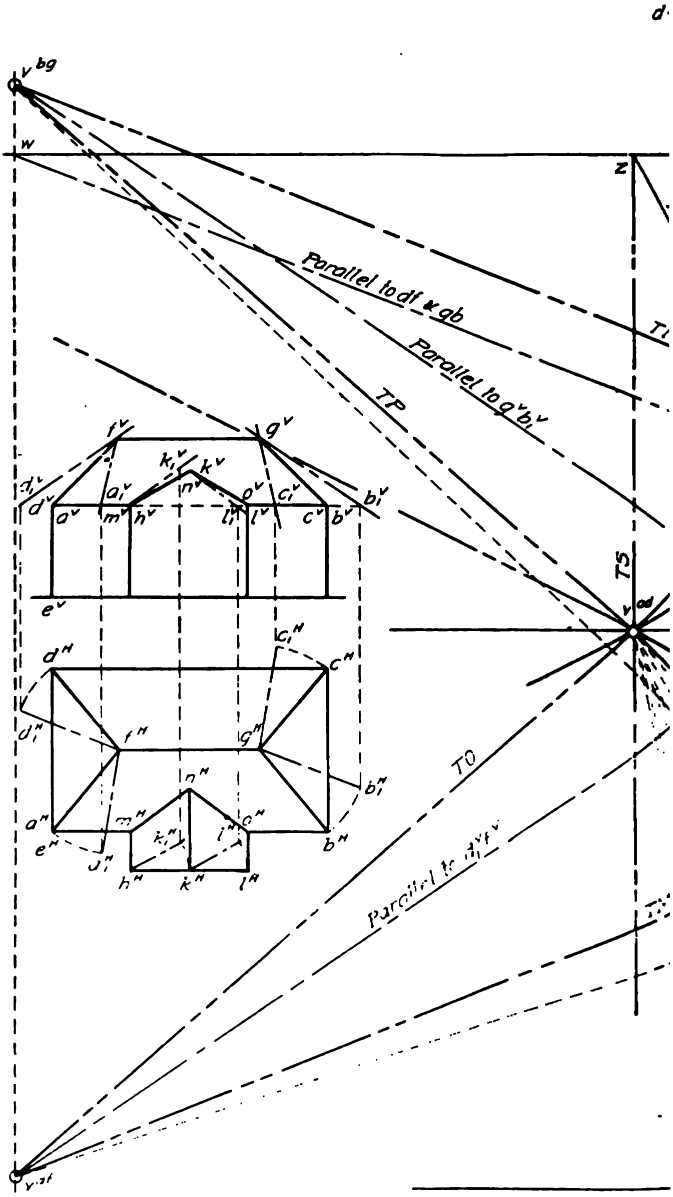
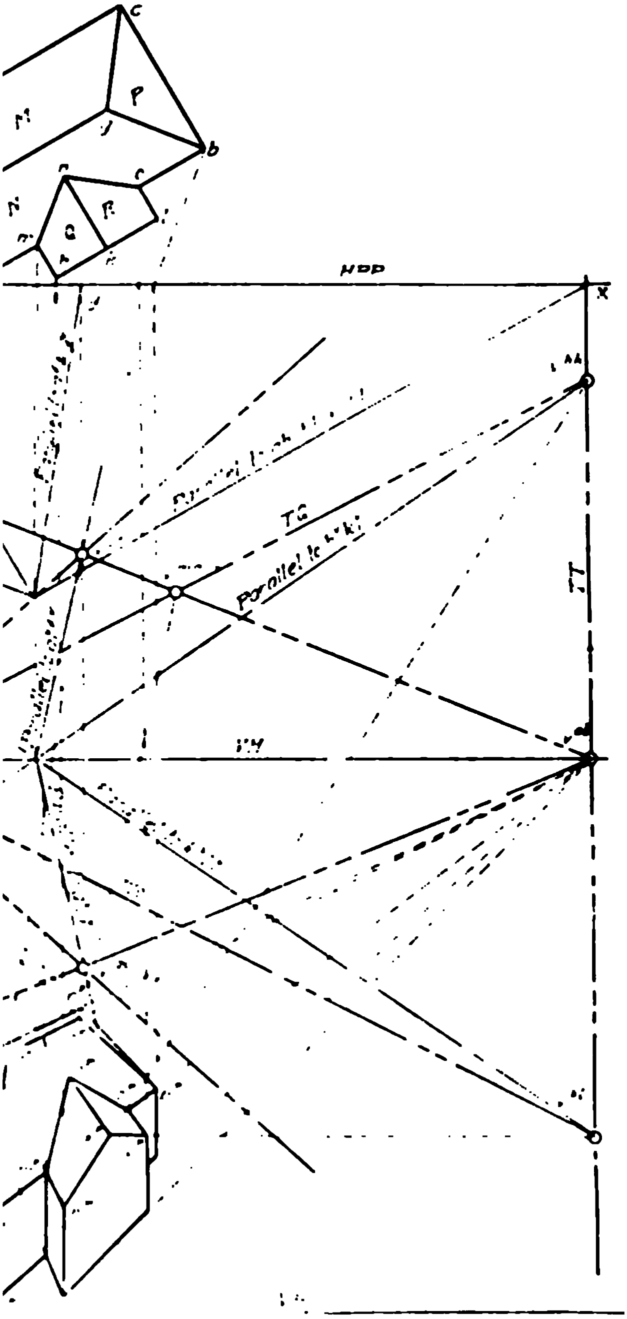
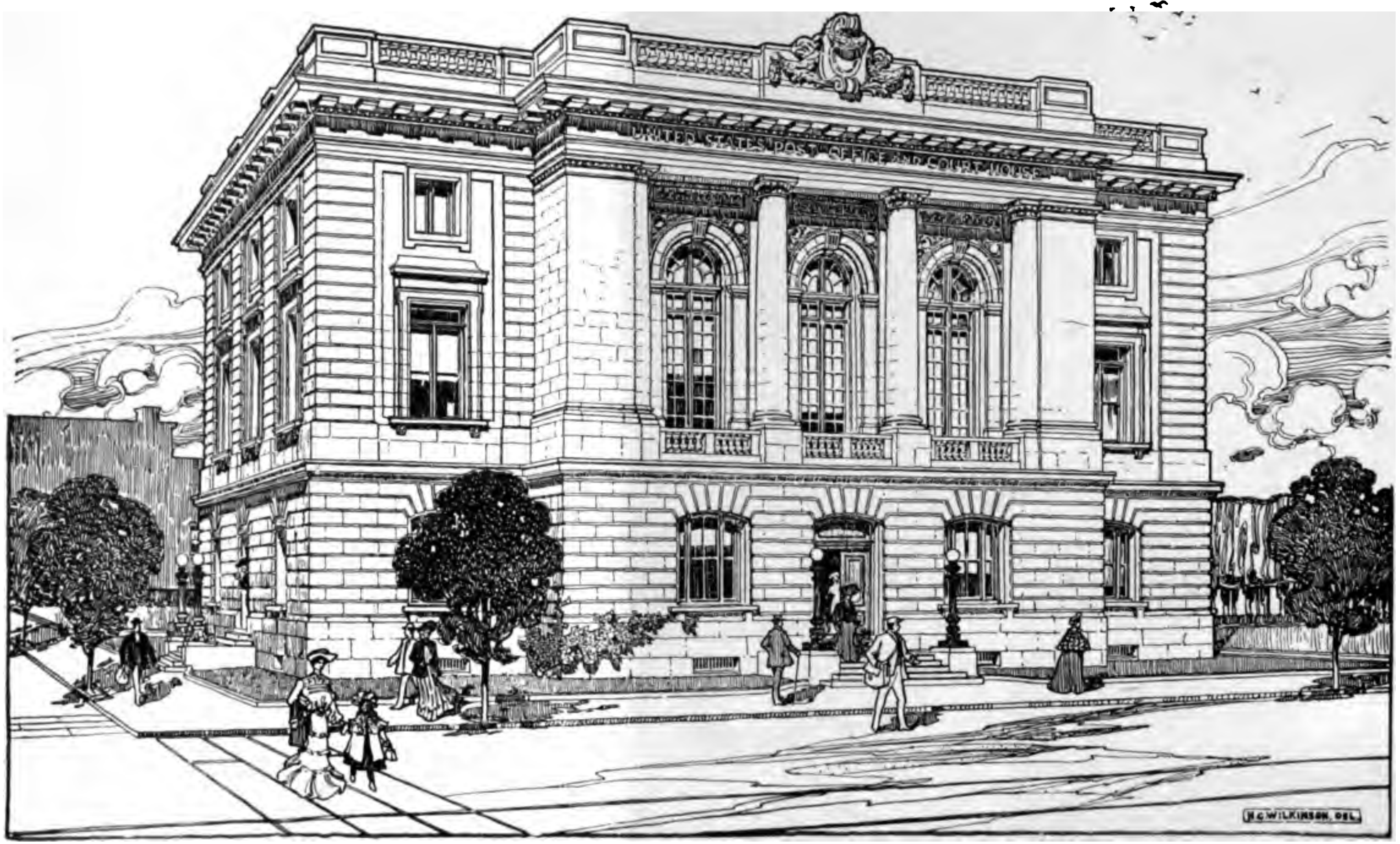


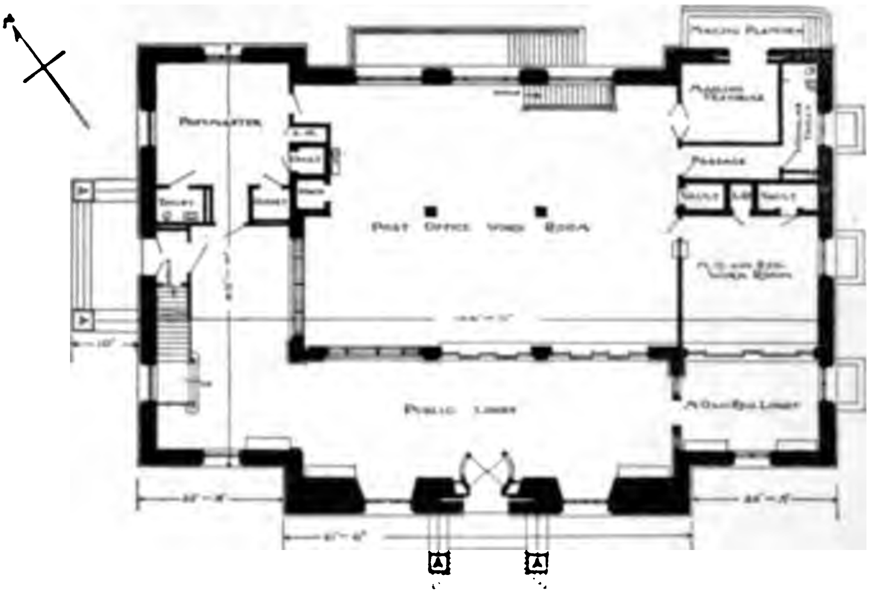
Fig 23. Diagram Showing Method of Finding Persp


c
P
M
d
b
N
Q
R
HPP
X
TG
Parallel to
TT
VH

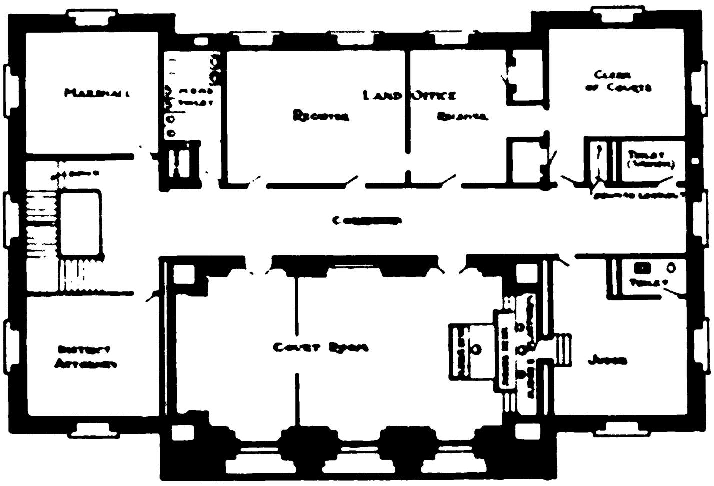
[illegible]


UNITED STATES POST OFFICE AND COURT HOUSE
H. C. WILKINSON, DEL.

POSTOFFICE AND COURTHOUSE, PIERRE, S. D.
J. Knox Taylor, Supervising Architect, Treasury Department, Washington, D. C., Architect.
Plans Shown on Following Page.



FIRST FLOOR · ASSIGNMENT · PLAN



SECOND · FLOOR · ASSIGNMENT · PLAN

PLANS OF POSTOFFICE AND COURTHOUSE, PIERRE, S. D.

J. Knox Taylor, Supervising Architect, Treasury Department, Washington, D. C., Architect.

For Perspective View, See Preceding Page.

belong to the same system, and should approach one another as they recede. Unless the points which determine them are found with great care, the two lines may approach too rapidly, or even diverge, as they recede from the eye. In the latter case, the drawing would be absolutely wrong in principle, and the result would be very disagreeable to the trained eye. If, however, the perspective of the vanishing point of the system to which these two lines belong, can be found, and the two lines be drawn to meet at this vanishing point, the result will necessarily be accurate.

The line through r^P, which forms the intersection between the roof of the house and the left hand face of the chimney, is a still more difficult one to determine accurately. Its length is so short that it is almost impossible to establish its exact direction from the perspective projections of its extremities. If the perspective of its vanishing point can be found, however, its direction at once becomes definitely determined.

67. It is not a difficult matter to find the perspective of the vanishing point for each system of lines in an object. The method is illustrated in Fig. 23. The general method for finding the perspective of the vanishing point for any system of lines has already been stated in § 24 *g*, and illustrated in Figs. 16, 17, and 18, §§ 50, 51, and 52. It remains only to adapt the general method to a particular problem, such as that shown in Fig. 23.

The plan and elevation of a house are given at the left of the figure. The diagram has been drawn at the top of the sheet, turned at the desired angle. The assumed position of the station point is indicated by its two projections, SP^V and SP^H. VH necessarily passes through SP^V.

68. In order to find the perspective of the vanishing point of any system of lines, the vertical and horizontal projections of some element of the system must be known (see method of Problem III.). The diagram gives the horizontal projection of every line in the object which is to appear in the perspective projection. The diagram, however, has been turned through a certain horizontal angle in order to show the desired perspective view, and there is no revolved elevation to agree with the revolved position of the diagram. A revolved elevation could, of course, be con-

structed by revolving the given plan of the object until all its lines were parallel to the corresponding lines in the diagram, and then finding the revolved elevation of the object corresponding to the revolved position of the plan.

NOTE. — The method of constructing a revolved elevation has been explained in detail in the Instruction Paper on Mechanical Drawing, Part III., Page 12.

Having constructed the revolved plan and elevation of the object to agree with the position of the diagram, we should then have the vertical and horizontal projections of a line parallel to each line that is to appear in the perspective drawing, and the method of Problem III. could be applied directly.

This is exactly the process that will be followed in finding the vanishing points for the oblique lines in the object, except that instead of making a complete revolved plan and elevation of the house, each system of lines will be considered by itself, and the revolved plan and elevation of each line will be found as it is needed, without regard to the remaining lines in the object.

69. All the lines in the house belong to one of eleven different systems that may be described as follows: —

A vertical system, to which all the vertical lines in the house belong. The perspective of the vanishing point of this system cannot be found within finite limits (§ 54).

Two horizontal systems parallel respectively to *ab* and *ad* (see diagram). The perspectives of the vanishing points of these systems will be found in VH (§ 24 *c*, note).

Five systems of lines vanishing upward, parallel respectively to *af*, *bg*, *mn*, *on*, and *hk* (see diagram). The perspectives of the vanishing points of these systems will be found to lie above VH (§ 51, note).

Three systems of lines vanishing downward, parallel respectively to *fd*, *gc*, and *kl* (see diagram). The perspectives of the vanishing points of these systems will be found below VH (§ 51, note).

NOTE. — To determine whether a line vanishes upward or downward, proceed as follows: —

Examine the direction of the line as shown in the *diagram.* Determine which end of the line is the farther behind the picture plane. If the *more distant* end of the line is *above* the nearer end, the line vanishes *upward*, and the perspective of its vanishing point will be found above VH.

If, on the other hand, the *more distant* end of the line is *lower* than the nearer end, the line vanishes *downward*, and the perspective of its vanishing point will be found below VH.

For illustration, consider the line *bg.* The diagram shows the point *g* to be farther behind the picture plane than the point *b*, while the given elevation shows the point *g* to be higher than the point *b.* Therefore the line *rises* as it *recedes*, or, in other words, it *vanishes upward.*

In the case of the line *fd*, the diagram shows the point *d* to be farther behind the picture plane than the point *f*, while the elevation shows the point *d* to be lower than the point *f.* Therefore the line must vanish downward, and its vanishing point be found below VH.

If the horizontal projection of a line, as shown by the diagram, is parallel to HPP, the line itself is parallel to the picture plane, and the perspective of its vanishing point cannot be found within finite limits (§ 54, note). *The perspective projections of such a* *system of lines will show the true angle which the elements of the system make with the horizontal coordinate.*

70. The construction for the vanishing points in Fig. 23 is shown by dot and dash lines.

The vanishing points for the two systems of horizontal lines have been found at v^{ab} and v^{ad} respectively, as in the preceding problems.

Next consider the line *af*. The first step is to construct a revolved plan and elevation of this line to agree with the position of the diagram. Revolve the horizontal projection (a^Hf^H) of the line in the given plan about the point f^H, until it is parallel to the line *af* in the diagram. During this revolution, the point f^H remains stationary, while the point a^H describes a horizontal arc, until a^Hf^H has revolved into the position shown by the red line $a_1^H f^H$, which is parallel to the line *af* in the diagram. The vertical projection a^Vf^V must, of course, revolve with the horizontal projection. The point f^V remains stationary, while the horizontal arc described by the point *a* shows in vertical projection as a horizontal line. At every point of the revolution the vertical projection of the point *a* must be vertically in line with its horizontal projection. When a^H has reached the position a_1^H, a^V will be vertically above a_1^H at the point a_1^V, and $a_1^Vf^V$ will be the revolved elevation of the line.

We now have the vertical and horizontal projections ($a_1^Vf^V$ and $a_1^Hf^H$) of an element of the system to which the roof line, represented in the diagram by *af*, belongs. The vanishing point of this system may be determined as in Problem III. Draw through SP^H a line parallel to $a_1^Hf^H$ (or *af* in the diagram), representing the horizontal projection of the visual element of the system. Draw through SP^V a line parallel to $a_1^Vf^V$, representing the vertical projection of the visual element of the system. The visual element, represented by the two projections just drawn, pierces the picture plane at v^{af} (§ 45, note), giving the perspective of the vanishing point for the roof line, represented by *af* in the diagram.

In a similar manner the vanishing point for the roof line, represented in the diagram by *bg*, may be determined. First find, from the given plan and elevation of the object, a revolved plan and elevation of bg, to agree with the position of the line in the diagram. Revolve b^Hg^H in the given plan about the point g^H, until it is parallel to bg in the diagram, and occupies the position indicated by the line $b_1^Hg^H$. The corresponding revolved elevation is represented by the red line $b_1^Vg^V$.

$b_1^Hg^H$ and $b_1^Vg^V$ now represent respectively the horizontal and vertical projections of an element of the system to which the roof line, represented by bg in the diagram, belongs. The vanishing point of this system can be found by Problem III. Through SP^H draw a line parallel to $b_1^Hg^H$ (or bg in the diagram), representing the horizontal projection of the visual element of the system; and through SP^V draw a line parallel to $b_1^Vg^V$, representing the vertical projection of their visual element. The visual element, represented by these two projections, pierces the picture plane at v^{bg}, giving the perspective of the vanishing point of the roof line, represented in the diagram by the line bg.

By a similar process, $h^Hk_1^H$ and $h^Vk_1^V$ are found to represent respectively the horizontal and vertical projections of an element of the system to which belongs the roof line represented in the diagram by the line hk. The perspective of the vanishing point of this line has been found at v^{hk}.

v^{af}, v^{bg}, and v^{hk} have all been found to lie above VH (§ 51. note).

71. v^{fd}, v^{ce}, and v^{kl} are found exactly as were v^{af}, v^{bg}, and v^{hk}; but, as the systems to which they belong vanish downward, they will lie below VH (§ 51, note).

Thus, $f^Hd_1^H$ and $f^Vd_1^V$ are respectively the horizontal and vertical projections of an element of the system represented by fd in the diagram. A line drawn through SP^H, parallel to $f^Hd_1^H$ (or fd in the diagram), will intersect HPP in the point w. A vertical line through w will intersect a line through SP^V parallel to $f^Vd_1^V$, below VH.

72. Having found the perspectives of these vanishing points, the perspectives of the vanishing traces of all the planes in the object should be drawn as a test of the accuracy with which the vanishing points have been constructed. The roof planes in the house are lettered with the capital letters M, N, O, P, etc., on the diagram.

The plane O contains the lines *af*, *ad*, and *fd*. Therefore, the vanishing trace (TO) of the plane must be a straight line passing through the three vanishing points, v^{af}, v^{ad}, and v^{fd} (§ 24 *d*). If all three of these vanishing points do not lie in a straight line, it shows some inaccuracy, either in draughting or in the method used in finding some of the vanishing points. The student should not be content until the accuracy of his work is proved by drawing the vanishing trace of each plane in the object through the vanishing points of all lines that lie in that plane.

The plane M contains the lines *fd*, *gc*, and *dc*. The last line belongs to the system *ab*, and hence its vanishing point is v^{ab}. The vanishing trace (TM) of the plane M must pass through v^{fd}, v^{gc}, and v^{ab}.

Similarly, the vanishing trace (TP) of the plane P must pass through v^{gc}, v^{bg}, and v^{ad}. TN must pass through v^{ab}, v^{af}, and v^{bg}. TQ must pass through v^{hk} and v^{ad}. TR must pass through v^{kl} and v^{ad}.

73. The vanishing trace of a vertical plane will always be a *vertical line* passing through the vanishing points of all lines which lie in the plane. Therefore, the vanishing trace of the vertical planes in the house that vanish towards the left will be represented by a vertical line (TS) passing through v^{ad}.

The vanishing trace of the vertical planes of the house that vanish towards the right will be represented by a vertical line (TT) passing through v^{ab}. As the vertical plane which forms the face of the porch belongs to this system, and as this plane also contains the lines *hk* and *kl*, TT will be found to pass through v^{hk} and v^{kl} as well as v^{ab}.

74. It will be noticed that the vanishing points for the lines *mn* and *on* have not been found. These vanishing points might have been found in a manner exactly similar to that in which the other vanishing points were found, or they may be determined now, directly from the vanishing traces already drawn, in the following manner: —

The line *mn* is seen to be the line of intersection of the two planes N and Q. Therefore (§ 24 *e*) v^{mn} must lie at the intersection of TN and TQ.

For a similar reason, v^{on} must lie at the intersection of TN and TR. TN and TR do not intersect within the limits of the plate, but they are seen to converge as they pass to the ieft, and, if produced in that direction, would meet at the vanishing point for the line *on*.

75. Having found v^{ab}, v^{ad}, v^{hg}, and v^{fd}, TN could have been drawn through v^{ab} and v^{hg}; and TO could have been drawn through v^{ad} and v^{fd}. As *af* is the intersection of the two planes N and O, v^{af} could have been found at the intersection of TN and TO without actually constructing this vanishing point.

Similarly, v^{gc} could have been determined by the intersection of TM and TP.

By an examination of the plate, the student will notice that the vanishing point for each line in the object is formed at the intersection of the vanishing traces of the two planes of which the line forms the intersection. Thus, the line *ad* forms the intersection between the plane O and the left hand vertical face of the house. v^{ad} is found at the intersection of TO and TS.

The line *fg*, which forms the ridge of the roof, is the intersection of the planes M and N. The vanishing point for *fg* is v^{ab}, and TM and TN will be found to intersect at v^{ab}. v^{hk} is found at the intersection of TQ and TT, v^{kl} is found at the intersection of TR and TT, etc.

It will be noticed also that the two lines *hk* and *kl* lie in the same vertical plane, and make the same angle with the horizontal, one vanishing upward, and one vanishing downward. Since both lines lie in the same vertical plane, both of their vanishing points will be found in the vertical line which represents the vanishing trace of that plane. Also, since both lines make equal angles with the horizontal, the vanishing point of the line vanishing upward will be found as far above VH as the vanishing point of the line vanishing downward is below VH.

In a similar way, the line *hg* vanishes upward, and the line *fd* vanishes downward; each making the same angle with the horizontal (as shown by the given plan and elevation). These two lines do not lie in the same plane, but may be said to lie in two imaginary vertical planes which are parallel to one another. Their vanishing points will be seen to lie in the same vertical line, v^{hg} being as far above VH as v^{fd} is below it.

As a general statement, it may be said that if two lines lie in the same or parallel vertical planes, and make equal angles with the horizontal, one vanishing upward and the other vanishing downward, the vanishing points for both lines will be found vertically in line with one another, one as far above VH as the other is below it.

This principle is often of use in constructing the vanishing point diagram. Thus, having found v^{hk}, v^{kl} could have been determined immediately by making it lie in a vertical line with v^{hk}, and as far below VH as v^{hk} is above it.

VANISHING POINT DIAGRAM.

76. The somewhat symmetrical figure formed by the vanishing traces of all the planes in the object, together with all vanishing points, HPP, and the vertical and horizontal projections of the station point, is called the *Vanishing Point Diagram* of the object.

77. Having found the complete vanishing point diagram of the house, the perspective projection may be drawn. VH$_1$ may be chosen in accordance with the kind of a perspective projection it is desired to produce (§ 29). In order that all the roof lines may be visible, VH$_1$ has been chosen far below VH. The resulting perspective is a somewhat exaggerated bird's-eye view.

The point e^P will be found on VH$_1$, vertically under the point e in the diagram. a^Pe^P lies in the picture plane, and shows the true height of the vertical wall of the house. From a^P and e^P, the horizontal edges of the walls of the main house vanish to v^{ab} and v^{ad}.

The points d^P, b^P, m^P, and o^P are found on the upper horizontal edges of the main walls, vertically under the points where HPP is crossed by visual rays drawn through the points d, b, m, and o in the diagram. Vertical lines from d^P and b^P complete the visible vertical edges of the main house.

In a similar manner the perspective of the vertical walls of the porch is obtained.

Each roof line vanishes to its respective vanishing point. a^Pf^P vanishes at v^{af}. f^Pd^P vanishes at v^{fd}. These two lines intersect in the point f^P. The ridge of the main house passes through f^P, vanishing at v^{ab}. g^Pe^P vanishes at v^{gc}, passing through the point e^P, which has already been determined by the intersection of the two upper rear horizontal edges of the main walls. b^Pg^P vanishes at v^{bg}, completing the perspective of the main roof.

In the porch, h^Pk^P vanishes at v^{hk}, passing through the point h^P, already determined by the vertical walls of the porch. k^Pl^P passes through l^P, and vanishes at v^{kl}. From k^P the ridge of the porch roof vanishes at v^{ad}. From m^P, a line vanishing at v^{mn} will intersect the ridge in the point n^P, and represent the intersection of the roof planes Q and N. The vanishing point for o^Pn^P falls outside the limits of the plate. o^Pm^P may be connected with a line which, if the drawing is accurate, will converge towards both TN and TR, and, if produced, would meet them at their intersection.

78. While constructing the vanishing point diagram of an object, the student should constantly keep in mind the general statements made in the note under § 69.

Plate IV. should now be solved.

PARALLEL OR ONE-POINT PERSPECTIVE.

79. When the diagram of an object is placed with one of its principal systems of horizontal lines parallel to the picture plane, it is said to be in **Parallel Perspective.** This is illustrated in Fig. 24, by the rectangular block there shown. One system of horizontal lines in the block being parallel to the picture plane, the other system of horizontal lines must be perpendicular to the picture plane. The vanishing point for the latter system will be coincident with SP^V (§ 52). The horizontal system that is parallel to the picture plane will have no vanishing point within finite limits (§ 54, with note; also last paragraph of note under § 69). The third system of lines in the object is a vertical one, and will have no vanishing point within finite limits (§ 54). Thus, of the three systems of lines that form the edges of the block, only one will have a vanishing point within finite limits. This fact has led to the term One-Point Perspective, which is often applied to an object in the position shown in Fig. 24. As will be seen, this

is only a special case of the problems already studied, and the construction of the perspective of an object in parallel perspective is usually simpler than when the diagram is turned at an angle with HPP.

80. The vertical face (*abfe*) of the block lies in the picture plane. It will thus show in its true size and shape (§ 24 *h*). The

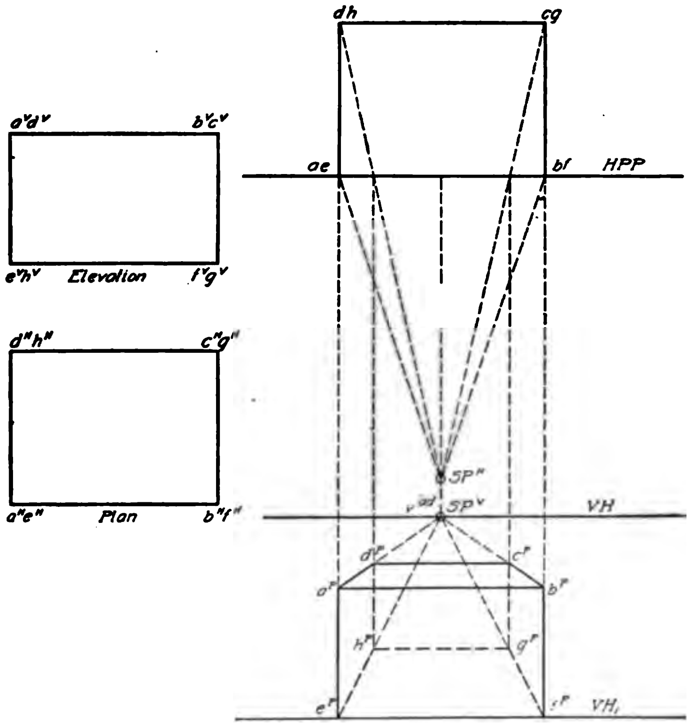


Fig. 24. Diagram Showing Method of Drawing Parallel, or One-Point, Perspective

points e^P and f^P will be found on VH_1 vertically below the points *e* and *f* in the diagram.

81. Both the edges $e^P a^P$ and $f^P b^P$ are lines of measures, and will show the true height of the block, as given by the elevation.

82. The two lines $a^P b^P$ and $e^P f^P$, since they are formed by the intersection of the bases of the block with the picture plane, will also be lines of measures (§ 55), and will show the true length of the block, as given by the plan and elevation.

83. The perspective of the front face of the block, which is

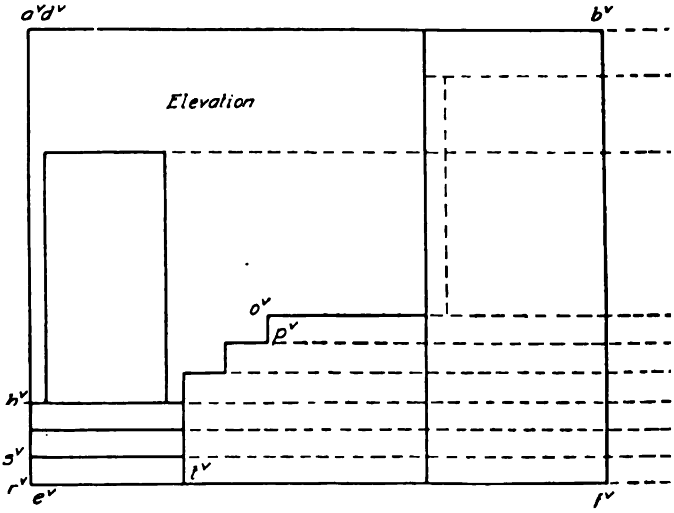
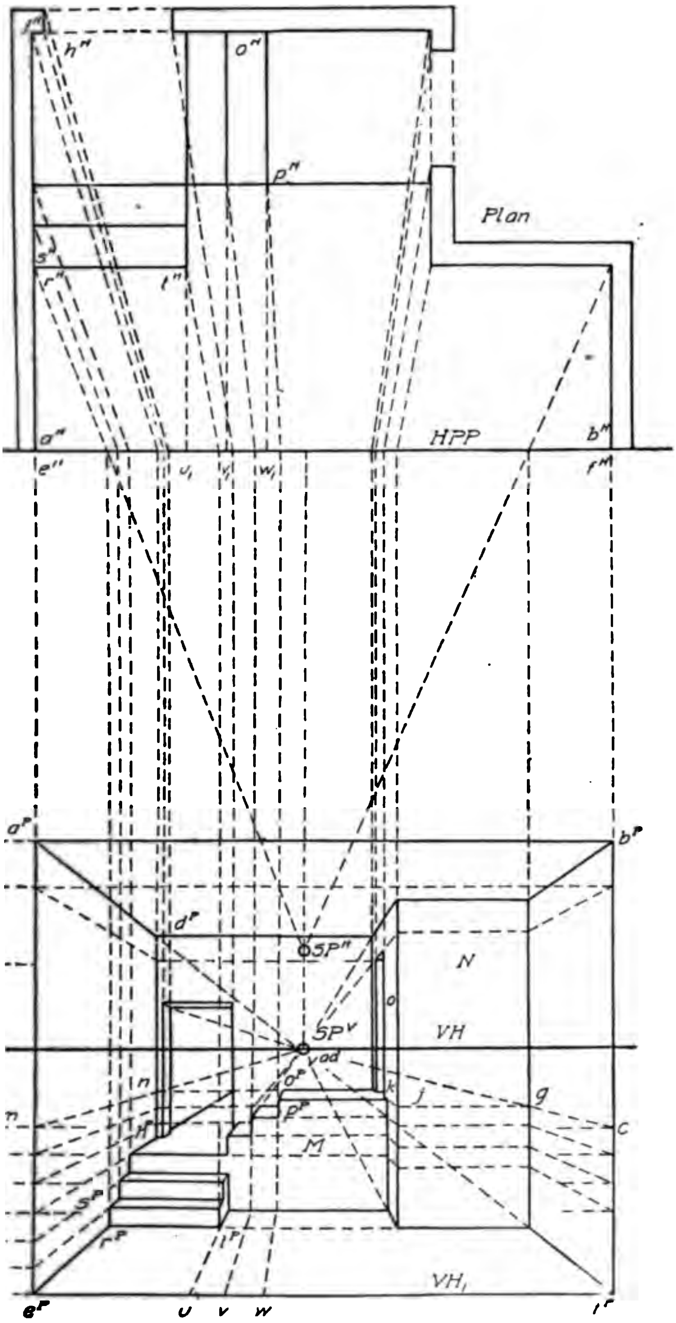


Fig. 25. Diagram Showing Metho



ing an Interior Parallel Perspective

coincident with the picture plane, can be drawn immediately. From a^P, b^P, e^P, and f^P, the horizontal edges, which are perpendicular to the picture plane, will vanish at v^{ad} (coincident with SP^V). The rear vertical edges of the block may be found in the usual manner.

84. The lines a^Pb^P, d^Pc^P, e^Pf^P, and h^Pg^P, which form the horizontal edges parallel to the picture plane, will all be drawn parallel to one another (§ 54, note); and since the lines in space which they represent are horizontal, a^Pb^P, d^Pc^P, e^Pf^P, and h^Pg^P will all be horizontal (see last paragraph of note under § 69).

All of the principles that have been stated in connection with the other problems will apply equally well to an object in parallel perspective.

85. Interior views are often shown in parallel perspective. One wall of the interior is usually assumed coincident with the picture plane, and is not shown in the drawing. For illustration, the rectangular block in Fig. 24 may be considered to represent a hollow box, the interior of which is to be shown in perspective. Assume the face ($a^Pb^Pf^Pe^P$) that lies in the picture plane to be removed. The resulting perspective projection would show the interior of the box. In making a parallel perspective of an interior, however, VH is usually drawn lower than is indicated in Fig. 24, in order to show the inside of the upper face, or ceiling, of the interior. With such an arrangement, three walls, the ceiling, and the floor of the interior, may all be shown in the perspective projection.

86. Fig. 25 shows an example of interior parallel perspective. The plan of the room is shown at the top of the plate. This has been placed so that it may be used for the diagram, and save the necessity of making a separate drawing. The elevation of the room is shown at the left of the plate, and for convenience it has been placed with its lower horizontal edge in line with VH_1. In this position all vertical dimensions in the object may be carried by horizontal construction lines directly from the elevation to the vertical line of measures (a^Pe^P or b^Pf^P) in the perspective projection.

87. The front face of the room ($a^Pb^Pf^Pe^P$), which is coincident with the picture plane, may first be established. Each point

in the perspective of this front face will be found to lie vertically under the corresponding point in plan, and horizontally in line with the corresponding point in elevation. Thus, a^P is vertically under a^H, and horizontally in line with a^V.

All lines in the room which are perpendicular to the picture plane vanish at v^{ad} (coincident with SP^V).

Drawing visual rays from every point in the diagram, the corresponding points in the perspective projection will be vertically under the points where these visual rays intersect HPP. The construction of the walls of the room should give the student no difficulty.

88. In finding the perspective of the steps, the vertical heights should first be projected by horizontal construction lines from the elevation to the line of measures (a^Pe^P), as indicated by the divisions between e^P and m. These divisions can then be carried along the left hand wall of the room by imaginary horizontal lines vanishing at v^{ad}. The perspective of the vertical edge where each step intersects the left hand wall may now be determined from the plan. Thus, the edge s^Pr^P of the first step is vertically below the intersection of HPP with a visual ray drawn through the point s^H in plan, and is between the two horizontal lines projected from the elevation that show the height of the lower step. The corresponding vertical edge of the second step will be projected from the plan in a similar manner, and will lie between the two horizontal lines projected from the elevation that show the height of the second step, etc.

From s^P the line which forms the intersection of the wall with the horizontal surface of the first step will vanish to v^{ad}, etc.

From r^P the intersection of the first step with the floor of the room will be a line belonging to the same system as a^Pb^P, and will therefore show as a true horizontal line. The point t^P may be projected from the diagram by a visual ray, as usual. From t^P the vertical edge of the step may be drawn till it intersects a horizontal line through s^P, and so on, until the steps that rest against the side wall are determined.

89. The three upper steps in the flight rest against the rear wall. The three upper divisions on the line e^Pm may be carried along the left hand wall of the room, as indicated, till they inter-

sect the rear vertical edge of the wall, represented by the line $d^P h^P$. From these intersections the lines may be carried along the rear wall of the room, showing the heights of the three upper steps where they rest against the rear wall.

The three upper divisions on the line $e^P m$ have also been projected across to the line $f^P h^P$, and from this line carried by imaginary horizontal lines along the right hand wall of the room to the plane N, across the plane N to the plane O, and from the plane O to the plane M. Thus, for illustration, the upper division, representing the height of the upper step, has been carried from m to e; from e to g along the right hand face of the wall; from g to j along the plane N; from j to k on the plane O, and from k to p^P on the plane M.

The point p^P is where the line which represents the height of the upper step meets a vertical dropped from the intersection of HPP with a visual ray through the point p^H in the diagram. p^P is one corner in the perspective of the upper step, the visible edges of the step being represented by a horizontal line, $p^P k$, a line ($p^P o^P$) vanishing at v^{sd}, and a vertical line drawn from p^P between the two horizontal lines on the plane H, which represent the height of the upper step. The point o^P is at the intersection of the line drawn through p^P, vanishing through v^{sd}, with the horizontal line on the rear wall drawn through the point n, and representing the upper step where it rests against the rear wall.

The remaining steps may be found in a similar manner. The student should have no difficulty in following out the construction, which is all shown on the plate.

90. The position of the point t^P on the line $r^P t^P$ was determined by projecting in the usual manner from the diagram. The position of t^P might have been found in the following manner: In the figure the line $e^P f^P$ is a line of measures (§ 81), and divisions on this line will show in their true size. Thus, if we imagine a horizontal line to be drawn through t^P, parallel to the wall of the room, it will intersect $e^P f^P$ in the point u. Since $e^P u$ is on a line of measures, it will show in its true length. Thus, t^P might have been determined by laying off $e^P u$ equal to the distance $e^H u_1$ taken from the plan, and then drawing through the point u a line van-

ishing at v^{ad}. The intersection of this line with the horizontal line drawn through r^P will determine t^P.

In a similar manner the vertical edges of the steps, where they intersect the plane M, might have been found by laying off from *u*, on e^Pf^P, the divisions *uv* and *vw* taken from the plan. These divisions could have been carried along the floor by horizontal lines parallel to the sides of the room (vanishing at v^{ad}), to the plane M, and then projected vertically upward on the plane M, as indicated in the figure. Solve Plate V.

METHOD OF PERSPECTIVE PLAN.

91. In the foregoing problems the perspective projection has been found from a diagram of the object. Another way of constructing a perspective projection is by the method of **Perspective Plan.** In this method no diagram is used, but a perspective plan of the object is first made, and from this perspective plan the perspective projection of the object is determined. The perspective plan is usually supposed to lie in an auxiliary horizontal plane below the plane of the ground. The principles upon which its construction is based will now be explained.

92. In Fig. 26, suppose the rectangle $a^Hb^Hc^Hd^H$ to represent the horizontal projection of a rectangular card resting upon a horizontal plane. The diagram of the card is shown at the upper part of the figure. It will be used only to explain the construction of the perspective plan of the card.

First consider the line *ad*, which forms one side of the card. On HPP lay off from *a*, to the left, a distance (*ae*) equal to the length of the line *ad*. Connect the points *e* and *d*. *ead* is by construction an isosceles triangle lying in the plane of the card, with one of its equal sides (*ae*) in the picture plane. Now, if this triangle be put into perspective, the side *ad*, being behind the picture plane, will appear shorter than it really is; while the side *ae*, which lies in the picture plane, will show in its true length.

Let VH_1 be the vertical trace of the plane on which the card and triangle are supposed to rest. The position of the station point is shown by its two projections SP^H and SP^V. The vanishing point for the line *ad* will be found at v^{ad} in the usual manner. In a similar way, the vanishing point for the line *ed*, which forms the base of the isosceles triangle, will be found at v^{ed}, as indicated. a^P will be found on VH$_1$ vertically under the point *a*, which forms the apex of the isosceles triangle *ead*. The line a^Pd^P will vanish at v^{ad}. The point e^P will be found vertically

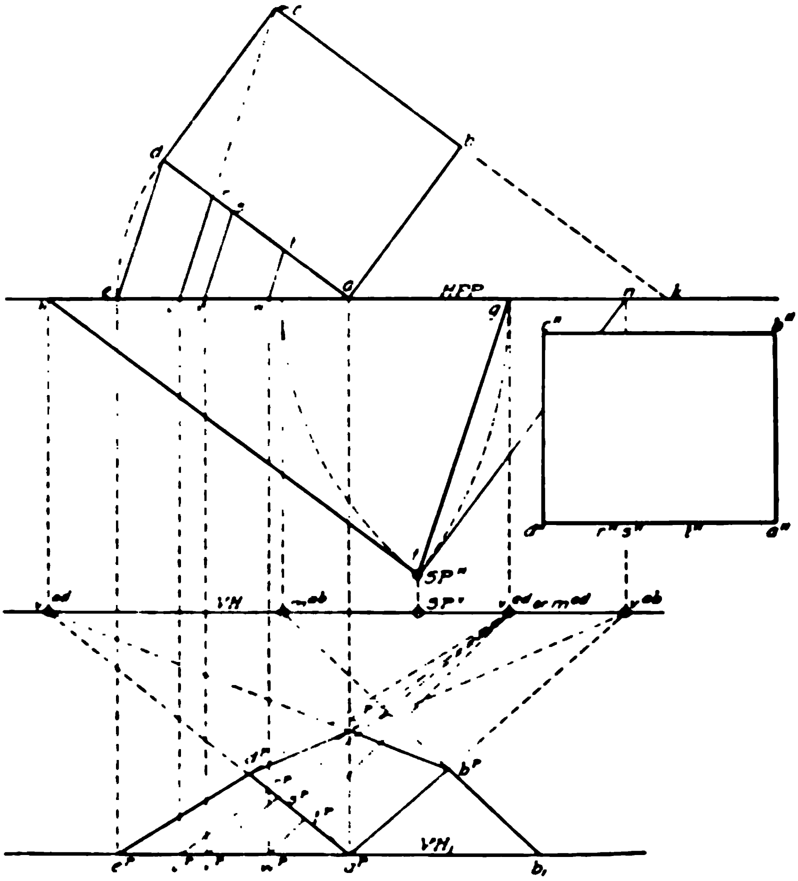


Fig. 26. Diagram Showing Perspective Constructed by Method of Perspective Plan

below the point *e*. e^Pd^P will vanish at v^{ed}, and determine by its intersection with a^Pd^P the length of that line. $e^Pa^Pd^P$ is the perspective of the isosceles triangle *ead*.

If the line *ad* in the diagram is divided in any manner by the points *t*, *s*, and *r*, the perspectives of these points may be found on the line a^Pd^P in the following way. If lines are drawn through the points *t*, *s*, and *r* in the diagram parallel to the base *de* of the isosceles triangle (*ead*), these lines will divide the line *ae* in a manner exactly similar to that in which the line *ad* is divided. Thus, *aw* will equal *at*, *wv* will equal *ts*, etc. Now, in the perspective projection of the isosceles triangle, a^Pe^P lies in the picture plane. It will show in its true length, and all divisions on it will show in their true size. Thus, on a^Pe^P lay off a^Pw^P, w^Pv^P, and v^Pu^P equal to the corresponding distances *at*, *ts*, and *sr*, given in the diagram. Lines drawn through the points w^P, v^P, and u^P, vanishing at v^{ed}, will be the perspective of the lines *wt*, *vs*, and *ur* in the isosceles triangle, and will determine the positions of t^P, s^P, and r^P, by their intersections with a^Pd^P.

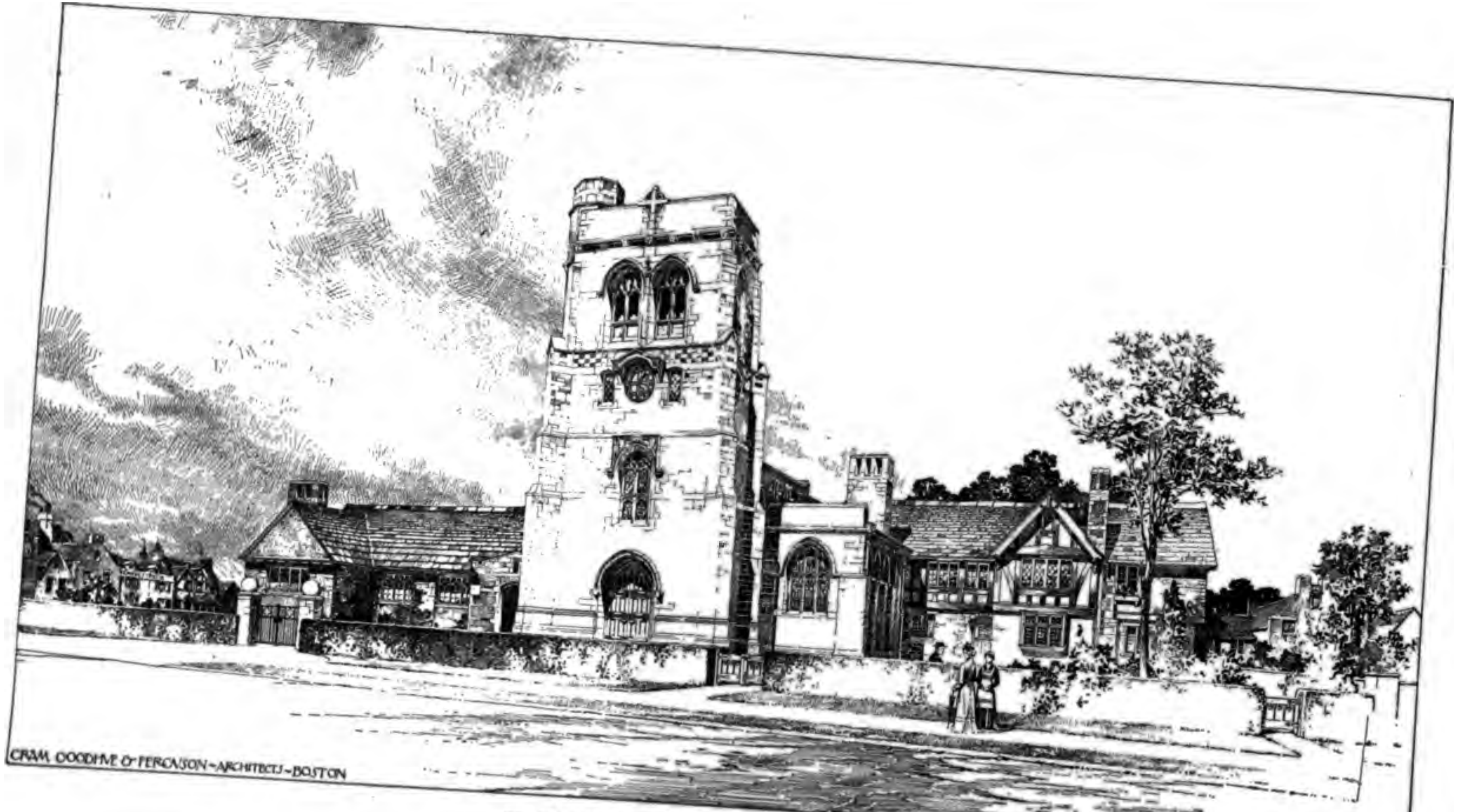
93. It will be seen that after having found v^{ad} and v^{ed}, the perspective of the isosceles triangle can be found without any reference to the diagram. Assuming the position of a^P at any desired point on VH_1, the divisions a^P, w^P, v^P, u^P, e^P may be laid off from a^P directly, making them equal to the corresponding divisions a^H, t^H, s^H, r^H, d^H, given in the plan of the card. A line through a^P vanishing at v^{ad} will represent the perspective side of the isosceles triangle. The length of this side will be determined by a line drawn through e^P, vanishing at v^{ed}. The positions of t^P, s^P, and r^P may be determined by lines drawn through w^P, v^P, and u^P, vanishing at v^{ed}.

94. It will be seen that the lines drawn to v^{ed} serve to measure the perspective distances $a^P\,t^P$, $t^P\,s^P$, $s^P\,r^P$, and $r^P\,d^P$, on the line a^Pd^P, from the true lengths of these distances as laid off on the line a^Pe^P. Hence the lines vanishing at v^{ed} are called **Measure Lines** for the line a^Pd^P, and the vanishing point v^{ed} is called a **Measure Point** for a^Pd^P.

95. Every line in perspective has a measure point, which may be found by constructing an isosceles triangle on the line in a manner similar to that just explained.

NOTE. — The vanishing point for the base of the isosceles triangle always becomes the measure point for the side of the isosceles triangle which does not lie in HPP.

96. All lines belonging to the same system will have the same measure point. Thus, if the line *bc*, which is parallel to *ad*, be continued to meet HPP, and an isosceles triangle (*cku*) con-


CRAM GOODHUE & FERGUSON ~ ARCHITECTS ~ BOSTON

ST. MARY'S CHURCH, WALKERVILLE, ONT.
Cram, Goodhue & Ferguson, Architects, Boston and New York.

structed on it, as indicated by the dotted lines in the figure, the base (*ae*) of this isosceles triangle will be parallel to *de*, and its vanishing point will be coincident with v^{de}.

97. There is a constant relation between the vanishing point of a system of lines and the measure point for that system. Therefore, if the vanishing point of a system of lines is known, its measure point may be found without reference to a diagram, as will be explained.

In constructing the vanishing points v^{ad} and v^{cd}, *fh* was drawn parallel to *ad*, *fg* was drawn parallel to *cd*, and since *hg* is coincident with HPP, the two triangles *cad* and *fhg* must be similar. As *ae* was made equal to *ad* in the small triangle, *hf* must be equal to *hg* in the large triangle; and consequently v^{cd}, which is as far from v^{ad} as *g* is from *h*, must be as far from v^{ad} as the point *f* is from the point *h*.

If the student will refer back to Figs. 8, 9, and 9a, he will see that the point *h* bears a similar relation in Fig. 26 to that of the point m^{H} in Figs. 8, 9, and 9a, and that the point *h* in Fig. 26 is really the horizontal projection of the vanishing point v^{ad}. (See also § 32.) Therefore, as v^{cd} is as far from v^{ad} as the point *h* is from the point *f*, we may make the following statement, which will hold for all systems of horizontal lines.

98. *The measure point for any system of horizontal lines will be found on VH as far from the vanishing point of the system as the horizontal projection of that vanishing point is distant from the horizontal projection of the station point.*

NOTE. — In accordance with the construction shown in Fig. 26, SP^{V} will always lie between the vanishing point of a system and its measure point.

99. The measure point of any system of lines is usually denoted by a small letter *m* with an index corresponding to its related vanishing point. Thus, m^{ab} signifies the measure point for the system of lines vanishing at v^{ab}.

100. The vanishing point for *ab* in Fig. 26 has been found at v^{ab}. The point *n*, in HPP, is the horizontal projection of this vanishing point. The measure point (m^{ab}) for all lines vanishing at v^{ab} will be found on VH, at a distance from v^{ab} equal to the distance from *n* to SP^{H} (98). In accordance with this statement,

m^{ab} has been found by drawing an arc with n as center, and with a radius equal to the distance from n to SP^H, and dropping from the intersection of this arc with HPP a vertical line. m^{ab} is found at the intersection of this vertical line with VH.

101. The perspective of ab has been drawn from a^P, vanishing at v^{ab}. a^Pb_1 on VH_1 is made equal to the length of a^Hb^H given in the plan of the card. A measure line through b_1, vanishing at m^{ab}, will determine the length of a^Pb^P. A line from b^P vanishing at v^{ad}, and one from d^P vanishing at v^{ab}, will intersect at c^P, completing the perspective plan of the card.

102. Even the vanishing points (v^{ab} and v^{ad}) for the sides of the card may be found without drawing a diagram. Since fn is drawn parallel to ab, it makes the same angle with HPP that ab makes. Similarly, since fh is drawn parallel to ad, it makes the same angle with HPP that ad makes. The angle between fn and fh must show the true angle made by the two lines ab and ad in the diagram. Therefore, having assumed SP^H, we have simply to draw two lines through SP^H, making with HPP the respective angles that the two sides of the cards are to make with the picture plane, care being taken that the angle these two lines make with one another shall equal the angle shown between the two sides of the card in the given plan. Thus, in Fig. 27, the two projections of the station point have first been assumed. Then through SP^H, two lines (fn and fh) have been drawn, making respectively, with HPP, the angles (H° and N°) which it is desired the sides of the card shall make with the picture plane, care being taken to make the angle between fn and fh equal to a right angle, since the card shown in the given plan is rectangular.

Verticals dropped to VH from the points n and h will determine v^{ab} and v^{ad}. Having found v^{ab} and v^{ad}, m^{ab} and m^{ad} should next be determined, as explained in § 98. VH_1 should now be assumed, and a^P chosen at any point on this line. It is well not to assume a^P very far to the right or left of an imaginary vertical line through SP^V.

From a^P the sides of the card will vanish at v^{ab} and v^{ad} respectively. Measure off from a^P on VH_1, to the right, a distance (a^Pb_1) equal to the length of the side a^Hb^H shown in the given plan. A measure line through b_1, vanishing at m^{ab}, will deter-

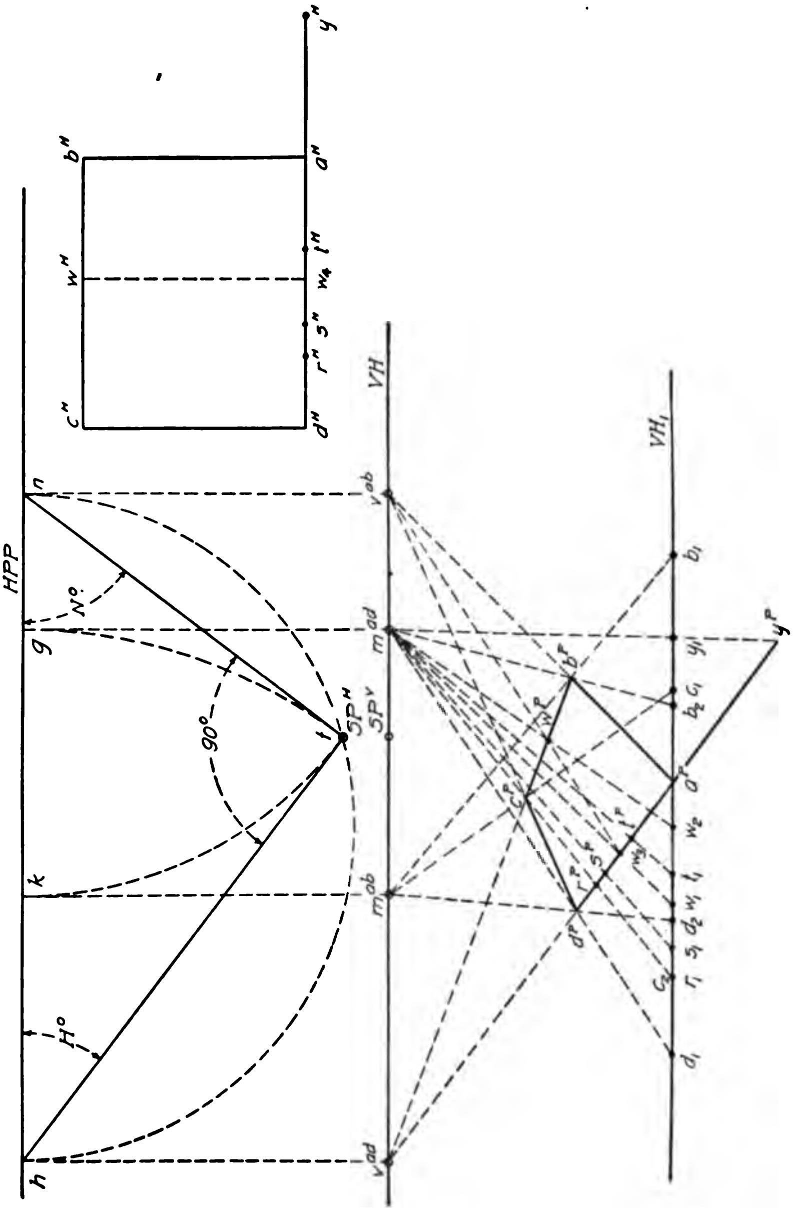


Fig. 27. Diagram Showing Method of Determining True Length of Lines by the Measure-Point System

mine the length of a^Pb^P. Measure off from a^P on VH_1, to the left, a distance (a^Pd_1) equal to the length of the side a^Hd^H shown in the given plan. A measure line through d_1 vanishing at m^{ad}, will determine the length of a^Pd^P.

From b^P and d^P, the remaining sides of the card vanish to v^{ad} and v^{ab} respectively, determining by their intersection the point c^P.

The line a^Hd^H in plan is divided by points t^H, s^H, and r^H. To divide the perspective (a^Pd^P) of this line in a similar manner, lay off on VH_1 from a^P, to the left, the divisions t_1, s_1, and r_1, as taken from the given plan. Measure lines through t_1, s_1, and r_1, vanishing at m^{ad}, will intersect a^Pd^P, and determine t^P, s^P, and r^P.

103. As has already been stated, the true length of any line is always measured on VH_1, and from the true length, the length of the perspective projection of the line is determined by measure lines vanishing at the measure point for the line whose perspective is being determined. Care must be taken to measure off the true length of the line in the proper direction. The general rule for doing this is as follows: —

If the measure point of any line is at the *right* of SP^V, the true length of the line will be laid off on VH_1 in such a manner that measurements for the *more distant* points in the line will be to the *left* of the measurements for the *nearer* points.

Thus, m^{ad} is at the *right* of SP^V. The point d^P is more distant than the point t^P. Therefore, the measurement (d_1) for the point d^P will be to the *left* of the measurement for the point t^P. In other words, since m^{ad} is to the *right* of SP^V, d_1, which represents a point more distant than t_1, must be to the *left* of t_1, the distance between t_1 and d_1 being equal to the true length of t^Pd^P, as shown by t^Hd^H in the given plan.

On the other hand, if the measure point for any system of lines is to the *left* of SP^V, the true measurements for any line of the system should be laid off on VH_1 in such a manner that measurements for more *distant points* on the line are to the *right* of measurements for the *nearer* points of the line.

Thus, m^{ab} is to the *left* of SP^V. The point b^P is *more distant* than the point a^P. Therefore, b_1, which shows the true measurement for the point b^P, must be laid off to the *right* of a^P.

104. It sometimes happens that a line extends in front of the picture plane, as has already been seen in the lines of the nearest corner of the porch in Fig. 22. It may be desired to extend the line a^Pd^P in Fig. 27, in front of the picture plane, to the point y^P, as indicated in the perspective projection. In this case, the point a^P being *more distant* than the point y^P, and m^{ad} being to the *right* of SP^V, the true measurement of a^Py^P must be laid off on VH_1 in such a manner that the measurement for a^P will be to the *left* of the measurement for y^P. In other words, y_1 must be on VH_1 to the right of a^P, the distance a^Py_1 showing the true length of a^Py^P.

NOTE. — The true length of any line which extends in front of the picture plane will be *shorter* than the perspective of the line.

105. Having determined the perspective of any line, as d^Pc^P, its true length may be determined by drawing measure lines through d^P and c^P. The distance intercepted on VH_1 by these measure lines will show the true length of the line. Thus, d^Pc^P vanishes at v^{ab}. Its measure point must therefore be m^{ab}. Two lines drawn from m^{ab}, and passing through c^P and d^P respectively, will intersect VH_1 in the points c_1 and d_2. The distance between c_1 and d_2 is the true length of c^Pd^P. This distance will be found equal to a^Pb_1, which is the true measure for the opposite and equal side (a^Pb^P) of the rectangle.

In a similar manner, the true length of b^Pc^P may be found by drawing measure lines from m^{ad} through b^P and c^P respectively. b_2c_2 will show the true length of c^Pb^P, and should be equal to a^Pd_2, which is the true length of the opposite and equal side (a^Pd^P) of the rectangle.

106. The perspective (w^P) of a point on one of the rear edges of the card may be determined in either of the following ways: —

1st. From b_2, which is the intersection with VH_1 of the measure line through b^P, lay off on VH_1, to the left (§ 103), the distance b_2w_2 equal to the b^Hw^H taken from the given plan. A measure line through w_2, vanishing at m^{ad}, will intersect c^Pb^P at the point w^P.

2d. In the given plan draw a line through w^H, parallel to a^Hb^H, intersecting a^Hd^H in the point w_4. On VH_1 make a^Pw_1 equal to a^Hw_4, as given in the plan. A measure line through w_1, vanishing at m^{ad}, will determine w_3 on a^Pd^P. From w_3, a line parallel to a^Pb^P (vanishing at v^{ab}) will determine, by its intersection with b^Pc^P, the position of w^P.

107. In making a perspective by the method of perspective plan, it is generally customary to assume VH and HPP coincident. That is to say, the coordinate planes are supposed to be in the position shown in Fig. 9, instead of being drawn apart as indicated in Fig. 9a. This arrangement simplifies the construction somewhat.

This is illustrated in Fig. 28, which shows a complete problem in the method of perspective plan. Compare this figure with Fig. 27, supposing that, in Fig. 27, HPP with all its related horizontal projections could be moved downward, until it just coincides with VH. The point n would coincide with v^{ab}, h with v^{ad}, and the arrangement would be similar to that shown in Fig. 28. All the principles involved in the construction of the measures, points, etc., would remain unchanged.

108. The vanishing points in Fig. 28 have first been assumed, as indicated at v^{ab} and v^{ad}. As the plan of the object is rectangular, SP^H may be assumed at any point on a semicircle constructed with $v^{ab}v^{ad}$ as diameter. By assuming SP^H in this manner, lines drawn from it to v^{ab} and v^{ad} respectively must be at right angles to one another, since any angle that is just contained in a semicircle must be a right angle. These lines show by the angles they make with HPP, the angles that the vertical walls of the object in perspective projection will make with the picture plane (§ 102).

109. m^{ad} and m^{ab} have been found, as explained in § 97, in accordance with the rule given in § 98.

VH_2 should next be assumed at some distance below VH, to represent the vertical trace of the horizontal plane on which the perspective plan is to be made (§ 91).

The position of a^P (on VH_2) may now be assumed, and the

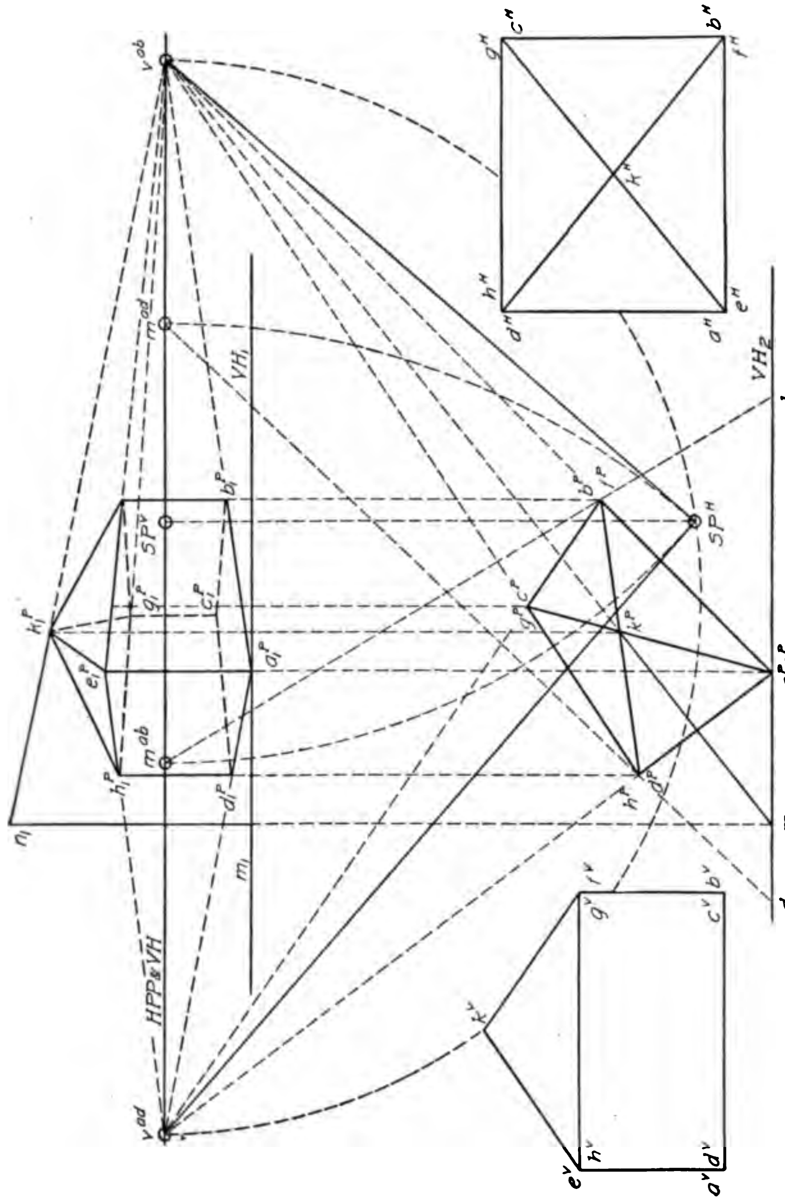


Fig. 28. Diagram of Complete Problem by Method of Perspective Plan in Which VH and HPP Are Coincident

perspective plan of the object constructed from the given plan, exactly as was done in the case of the rectangular card in Fig. 27.

110. Having constructed the complete perspective plan, every point in the perspective projection of the object will be found *vertically* above the corresponding point in the perspective plan.

VH_1 is the vertical trace of the plane on which the perspective projection is supposed to rest. a_1^P is found on VH_1 vertically over a^P in the perspective plan. $a_1^P e_1^P$ is a vertical line of measures for the object, and shows the true height given by the elevation.

To find the height of the apex (k_1^P) of the roof, imagine a horizontal line parallel to the line *ab* to pass through the apex, and to be extended till it intersects the picture plane. A line drawn through k^P, vanishing at v^{ab}, will represent the perspective plan of this line, and will intersect VH_2 in the point m, which is the perspective plan of the point where the horizontal line through the apex intersects the picture plane. The vertical distance n_1m_1, laid off from VH_1, will show the true height of the point k above the ground. k_1^P will be found vertically above k^P, and on the line through n_1 vanishing at v^{ab}. The student should find no difficulty in following the construction for the remainder of the figure.

111. Fig. 29 illustrates another example of a similar nature to that in Fig. 28. The student should follow carefully through the construction of each point and line in the perspective plan and in the perspective projection. The problem offers no especial difficulty.

Plate VI. should now be solved.

CURVES.

112. Perspective is essentially a science of straight lines. If curved lines occur in a problem, the simplest way to find their perspective is to refer the curves to straight lines.

If the curve is of simple, regular form, such as a circle or an ellipse, it may be enclosed in a rectangle. The perspective of the

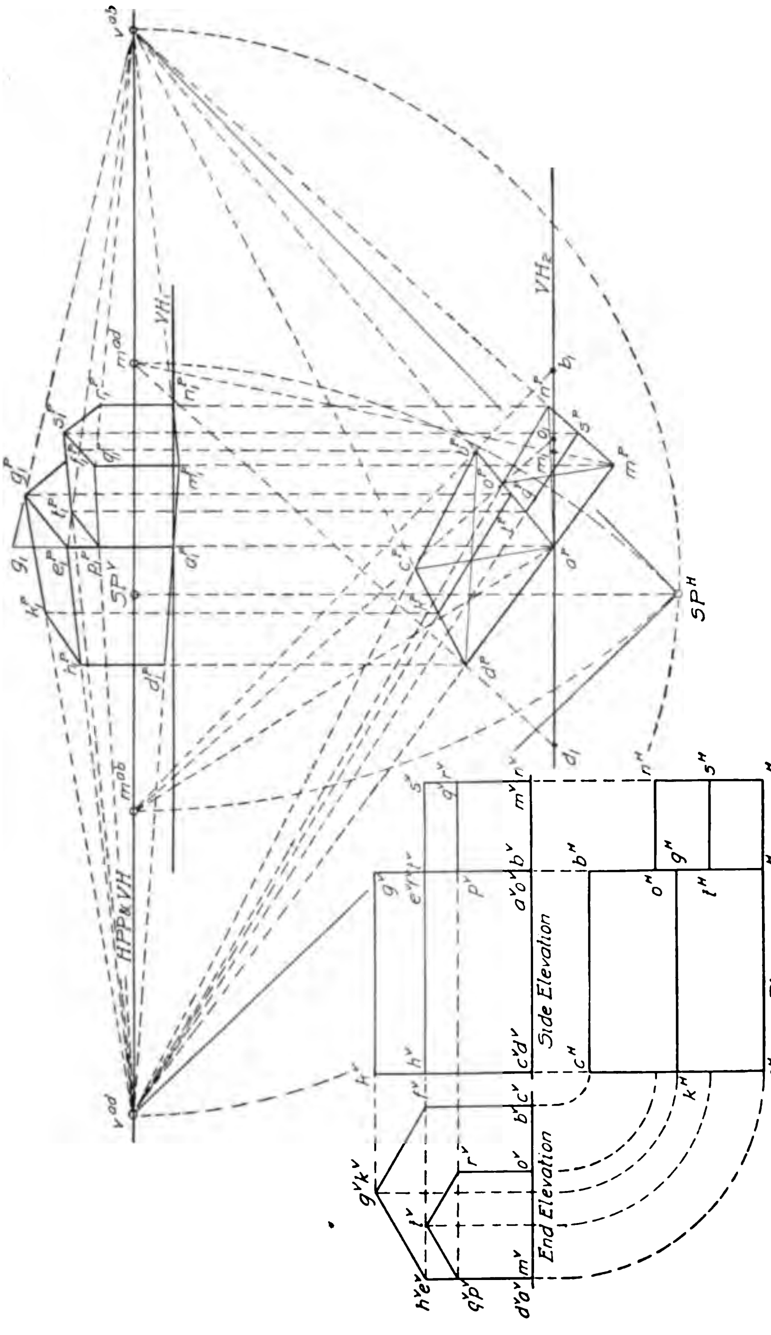


Fig. 29. Diagram Showing Perspective Plan Similar to Fig. 28

enclosing rectangle may then be found. A curve inscribed within this perspective rectangle will be the perspective of the given curve.

Fig. 30 shows a circle inscribed in a square. The points of intersection of the diameters with the sides of the square give the four points of tangency between the square and circle. The sides of the square give the directions of the circle at these points. Additional points on the circle may be established by drawing the diagonals of the square, and through the points m^H, k^H, n^H, and h^H drawing construction lines parallel to the sides of the square, as indicated in the figure.

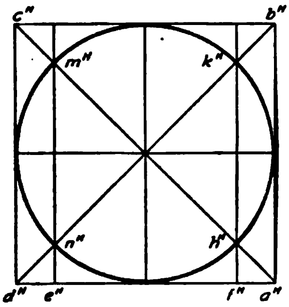


Fig. 30. Circle Inscribed in a Square

Fig. 31 shows the square, which is supposed to lie in a horizontal plane, in parallel perspective. One side of the square ($a^P d^P$) lies in the picture plane, and will show in its true size. The vanishing point for the sides perpendicular to the picture plane will coincide with SP^V (§ 52, note). The measure point for these sides has been found at m^{ab}, in accordance with principles already explained. $a^P b_1$ is laid off on VH_1 to the right of the point a^P, equal to the true length of the side of the square. A measure line through b_1, vanishing at m^{ab}, will determine the position of the point b^P. $b^P c^P$ will be parallel to $a^P d^P$ (§ 54, note).

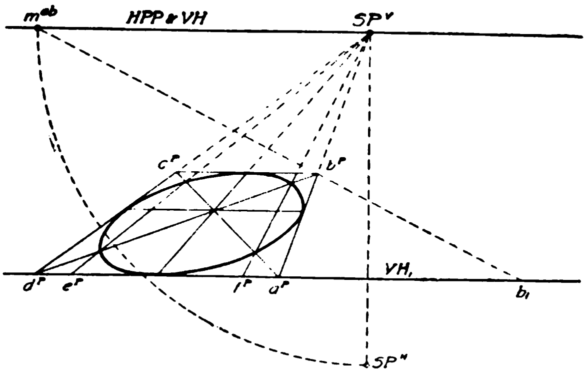


Fig. 31. Diagram Showing Square Lying in Horizontal Plane Drawn in Parallel Perspective

The diagonals of the square may be drawn. Their intersection will determine the perspective center of the square. The diameters will pass through this perspective center, one vanishing at SP^V, and the other being parallel to a^Vd^V (§ 54, note).

The divisions d^Ve^V and a^Vf^V will show in their true size. Lines through e^V and f^V, vanishing at SP^V, will intersect the diagonals of the square, giving four points on the perspective of the circle. Four other points on the perspective of the circle will be determined by the intersections of the diameter with the sides of the square. The perspective of the curve can be drawn as indicated.

113. If the curve is of very irregular form, such as that shown in Fig. 32, it can be enclosed in a rectangle, and the rectangle divided by lines, drawn parallel to its sides, into smaller rectangles, as indicated in the figure.

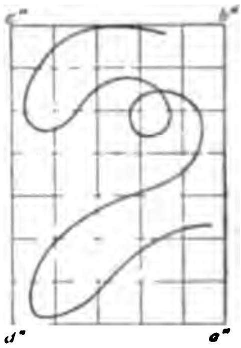


Fig. 32 Diagram of an Irregular Curve

The perspective of the rectangle with its dividing lines may then be found, and the perspective of the curve drawn in free hand. This is shown in Fig. 33. If very great accuracy is required, the perspectives of the exact points where the curve crosses the dividing lines of the rectangle may be found.

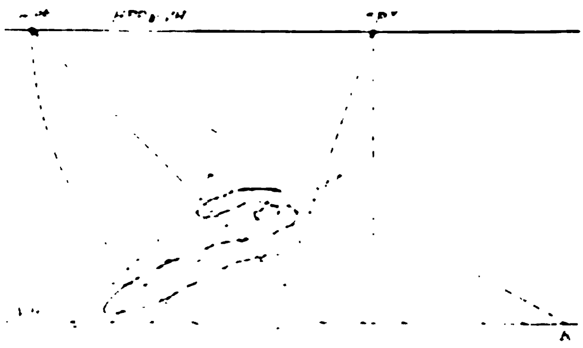


Fig. 33. Method of Making a Perspective of the Curve of Fig. 32

APPARENT DISTORTION.

114. There seems to exist in the minds of some beginners in the study of perspective, the idea that the drawing of an object made in accordance with geometrical rules may differ essentially from the appearance of the object in nature. Such an idea is erroneous, however. The only difference between the appearance of a view in nature and its correctly constructed perspective projection is that the view in nature may be looked at *from any point*, while its perspective representation shows the view as seen from one particular point, and from that point only.

For every new position that the observer takes, he will see a new view of the object in space, his eye always being at the apex of the cone of visual rays that projects the view he sees (see Fig. 1). In looking at an object in space, the observer may change his position as often as he likes, and will see a new view of the object for every new position that he takes.

115. This is not true of the perspective projection of the object, however. Before making a perspective drawing, the position of the observer's eye, or station point, must be decided upon, and the resulting perspective projection will represent the object as seen from this point, and from this point only. The observer, when looking at the drawing, in order that it may correctly represent to him the object in space, must place his eye exactly at the assumed position of the station point. If the eye is not placed exactly at the station point, the drawing will not appear absolutely correct, and under some conditions will appear much distorted or exaggerated.

116. Just here lies the defect in the science of perspective. It is the assumption that the observer has but one eye. Practically, of course, this is seldom the case. A drawing is generally seen with two eyes, and the casual observer never thinks of placing his eye in the proper position. Even were he inclined to do so, it would generally be beyond his power, as the position of the station point is seldom shown on the finished drawing.

117. As an illustration of apparent distortion, consider the perspective projection shown in Fig. 23. In order that the perspectives of the vanishing points might fall within the rather narrow limits of the plate, the station point in the figure has been assumed very close to the picture plane, the distance from HPP to SP^{H} showing the assumed distance from the paper at which the observer should place his eye in order to obtain a correct view of the perspective projection. This distance is so short it is most improbable that the observer will ordinarily place his eye in the proper position when viewing the drawing. Consequently the perspective projection appears more or less unnatural or distorted. But, for the sake of experiment, if the student will cut a small, round hole, one quarter of an inch in diameter, from a piece of cardboard, place it directly in front of SP^{V} and at a distance from the paper equal to the distance of SP^{H} from HPP, and if he will then look at the drawing through the hole in the cardboard, closing the eye he is not using, he will find that the unpleasant appearance of the perspective projection disappears.

It will thus be seen that unless the observer's eye is in the proper position while viewing a drawing, the perspective projection may give a very unsatisfactory representation of the object in space.

118. If the observer's eye is not very far removed from the correct position, the apparent distortion will not be great, and in the majority of cases will be unnoticeable. In assuming the position for the station point, care should be taken to choose such a position that the observer will naturally place his eyes there when viewing the drawing.

119. As a person naturally holds any object at which he is looking directly in front of his eyes, the first thought in assuming the station point should be to place it so that it will come very nearly in the center of the perspective projection.

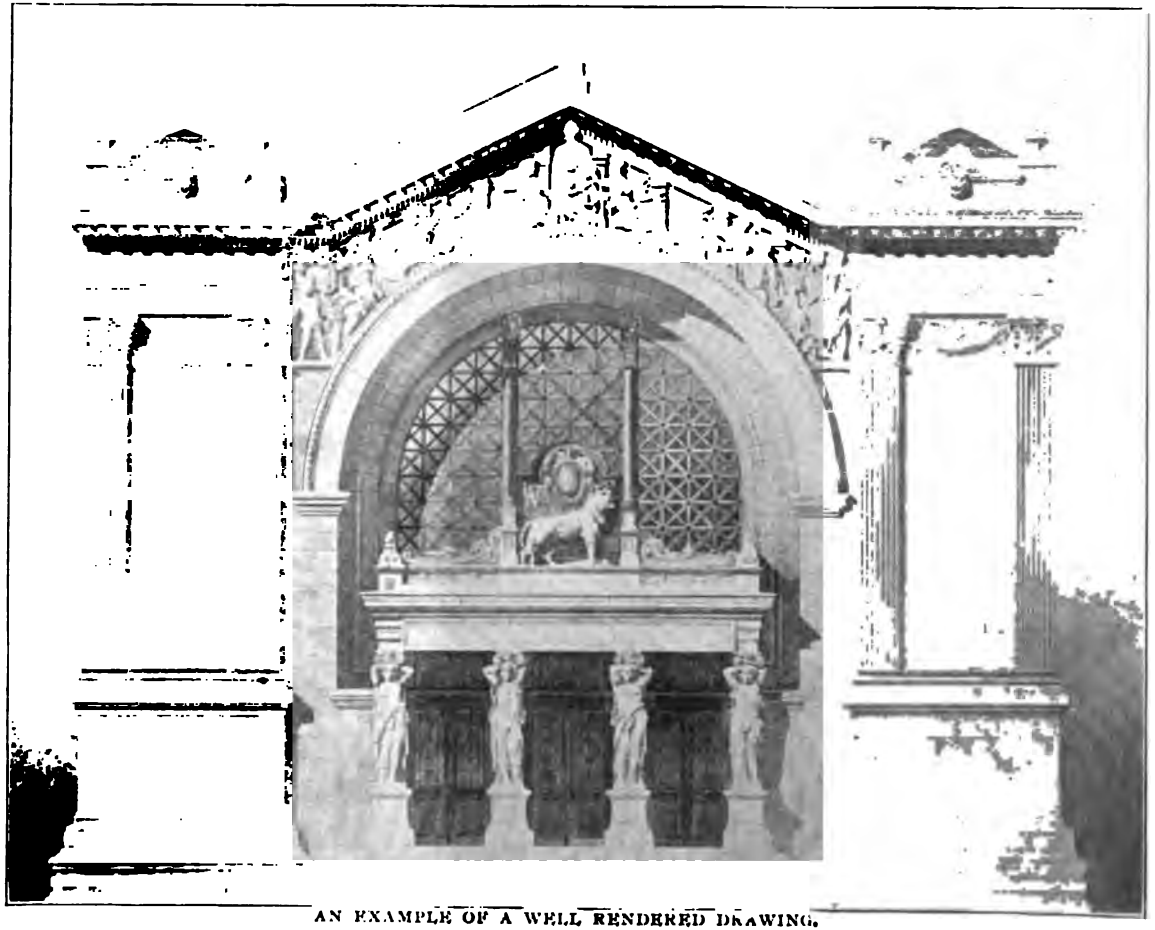
120. Furthermore, the normal eye sees an object most distinctly when about ten inches away. As one will seldom place a drawing nearer to his eye than the distance of distinct vision, a good general rule is to make the *minimum* distance between the station point and the picture plane about ten inches. For a small drawing, ten inches will be about right; but, as the drawing increases in size, the observer naturally holds it farther and farther from him, in order to embrace the whole without having to turn his eye too far to the right or left.

121. Sometimes a general rule is given to make the distance of the station point equal to the altitude of an equilateral triangle, having the extreme dimensions of the drawing for its base, and the station point for its apex.

122. The apparent distortion is always greater when the assumed position of the observer's eye is too near than when it is too far away. In the former case, objects do not seem to diminish sufficiently in size as they recede from the eye. On the other hand, if the observer's eye is between the assumed position of station point and the picture plane, the effect is to make the objects diminish in size somewhat too rapidly as they recede from the eye. This effect is not so easily appreciated nor so disagreeable as the former. Therefore it is better to choose the position of the station point too far away, rather than too near.

123. Finally, the apparent distortion is more noticeable in curved than in straight lines, and becomes more and more disagreeable as the curve approaches the edge of the drawing. Thus, if curved lines occur, great pains should be taken in choosing the station point; and, if possible, such a view of the object should be shown that the curves will fall near the center of the perspective.

124. The student should realize that the so-called distortion in a perspective projection is only an apparent condition. If the eye of the observer is placed exactly at the position assumed for it when making the drawing, the perspective projection will exactly represent to him the corresponding view of the object in space.



AN EXAMPLE OF A WELL RENDERED DRAWING.

Note the gradation of the shadows on the building from dark at the top to light at the bottom and the background from dark at the bottom to light at the top.

Reproduced by permission of Columbia University

SHADES AND SHADOWS

1. The drawings of which an architect makes use can be divided into two general kinds: those for designing the building and illustrating to the client its scheme and appearance; and "working drawings" which, as their name implies, are the drawings from which the building is erected. The first class includes "studies," "preliminary sketches," and "rendered drawings." Working drawings consist of dimensioned drawings at various scales, and full-sized details.

2. It is in the drawings of the first kind that "shades and shadows" are employed, their use being an aid to a more truthful and realistic representation of the building or object illustrated. All architectural drawings are conventional; that is to say, they are made according to certain rules, but are not pictures in the sense that a painter represents a building. The source of light casting the shadows in an architectural representation of a building is supposed to be, as in the "picture" of a building, the sun, but the direction of its rays is fixed and the laws of light observed in nature are also somewhat modified. The purpose of the architect's drawing is to explain the building, therefore the laws of light in nature are followed only to the extent in which they help this explanation, and are, therefore, not necessarily to be followed consistently or completely. The fixed direction of the sun's rays is a further aid to the purpose of an architectural drawing in that it gives all the drawings a certain uniformity.

3. **Definitions.** A clear understanding of the following terms is necessary to insure an understanding of the explanations which follow.

4. *Shade:* When a body is subjected to rays of light, that portion which is turned away from the source of light and which, therefore, does not receive any of the rays, is said to be in shade. See Fig. 1.

5. *Shadow:* When a surface is in light and an object is

placed between it and the source of light, intercepting thereby some of the rays, that portion of the surface from which light is thus excluded is said to be in shadow.

6. In actual practice distinction is seldom made between these terms "shade" and "shadow," and "shadow" is generally used for that part of an object from which light is excluded.

7. *Umbra:* That portion of space from which light is excluded is called the umbra or invisible shadow.

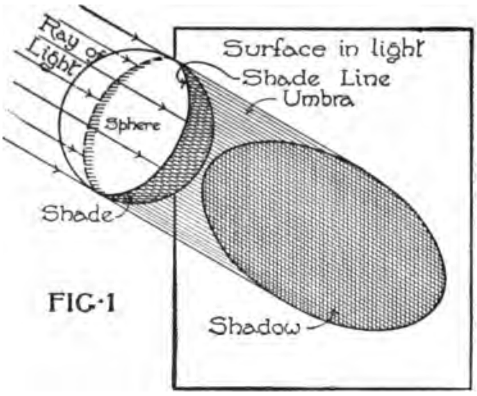
(a) The umbra of a point in space is evidently a line.

(b) The umbra of a line is in general a plane.

(c) The umbra of a plane is in general a solid.

(d) It is also evident, from Fig. 1, that the shadow of an object upon another object is the intersection of the umbra of the first object with the surface of the second object. For example, in Fig. 1, the shadow of the given sphere on the surface in light is the intersection of its umbra (in this case a cylinder) with the given surface producing an ellipse as the shadow of the sphere.

8. *Ray of light:* The sun is the supposed source of light in "shades and shadows," and the rays are propogated from it in straight lines and in all directions. Therefore, the ray of light can be represented graphically by a straight line. Since the sun is at an infinite distance, it can be safely assumed that the rays of light are all parallel.



FIG·1

9. *Plane of light:* A plane of light is any plane containing a ray of light, that is, in the sense of the ray lying in the plane.

10. *Shade line:* The line of separation between the portion of an object in light and the portion in shade is called the shade line.

11. It is evident, from Fig. 1, that this shade line is the boundary of the shade. It is made up of the points of tangency of rays of light tangent to the object.

12. It is also evident that the shadow of the object is the space enclosed by the shadow of the shade line. In Fig. 1, the

shade line of the given sphere is a great circle of the sphere. The shadow of this great circle on the given plane is an ellipse. The portion within the ellipse is the shadow of the sphere.

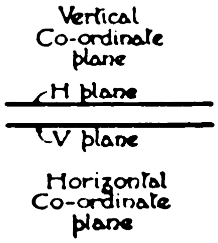
NOTATION.

13. In the following explanations the notation usual in orthographic projections will be followed:

H	horizontal co-ordinate plane.
V	vertical co-ordinate plane.
a	point in space.
a^v	vertical projection (or elevation) of the point.
a^h	horizontal projection (or plan) of the point.
a^{vs}	shadow on V of the point a.
a^{hs}	shadow on H of the point a.
R	ray of light in space.
R^v	vertical projection (or elevation) of ray of light.
R^h	horizontal projection (or plan) of ray of light.
GL	ground line, refers to a plane on which a shadow is to be cast, and *is that projection of the plane which is a line.*

14. In orthographic projection a given point is determined by "projecting" it upon a vertical and upon a horizontal plane. In representing these planes upon a sheet of drawing paper it is evident, since they are at right angles to each other, that when the plane of the paper represents V (the vertical "co-ordinate" plane), the horizontal "co-ordinate" plane H, would be seen and represented as a horizontal line, Fig. 2. *Vice versa*, when the plane of the paper represents H (the horizontal co-ordinate plane), the vertical co-ordinate plane V, would be seen and represented by a horizontal line, Fig. 2.

FIG·2



15. In architectural drawings having the elevation and plans upon the same sheet, it is customary to place the "elevation," or vertical projection, above the plan, as in Fig. 2.

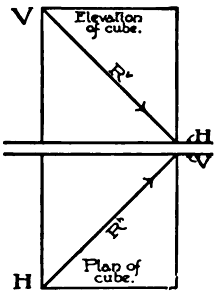
It is evident that the distance between the two ground lines can be that which best suits convenience.

16. As the problems of finding the shades and shadows of objects are problems dealing with points, lines, surfaces, and solids, they are dealt with as problems in Descriptive Geometry. It is assumed that the student is familiar with the principles of orthographic projection. In the following problems, the objects are referred to the usual co-ordinate planes, but as it is unusual in architectural drawings to have the plan and elevation on the same sheet, two ground lines are used instead of one.

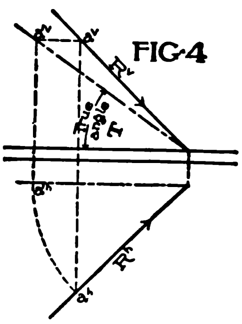
17. **Ray of Light.** The assumed direction of the conventional ray of light R, is that of the diagonal of a cube, sloping downward, forward and to the right; the cube being placed so

that its faces are either parallel or perpendicular to H and V. Fig. 3 shows the elevation and plan of such a cube and its diagonal. It will be seen from this that *the H and V projections of the ray of light make angles of 45° with the ground lines. The true angle* which the actual ray in space makes with the co-ordinate planes is 35° 15′ 52′ This true angle can be determined as shown in Fig. 4. Revolve the ray parallel to either of the co-ordinate planes. In Fig. 4, it has been revolved parallel to V, hence **T is** its true angle.

FIG·3



FIG·4



18. It is important in the following explanations to realize the difference in the terms "ray of light," and "projections of the ray of light."

SHADOWS OF POINTS.

19. **Problem I. To find the shadow of a given point on a given plane.**

Fig. 5 shows the plan and elevation of a given point *a*. It is required to find its shadow on a given plane, in this case the V plane. The shadow of the point *a* on V will be the point at which the ray of light passing through *a* intersects V.

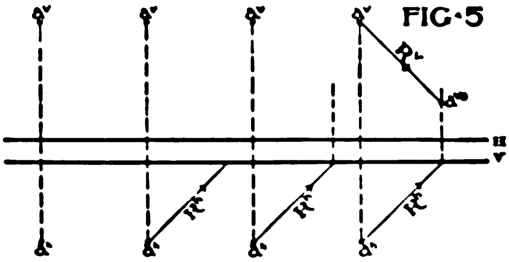
Through the H projection a^h, of the given point, draw R^h until it intersects the lower ground line. This means that the ray of light through *a* has pierced V at some point. The exact point will be on the perpendicular to the ground line, where R^v drawn through a^v intersects the perpendicular. The point a^{vs} is, therefore, the shadow of *a* on the V plane.

R^v is also the V projection of the *umbra* of the point *a* and it will be seen that the shadow of *a* on V is the intersection of its umbra with V.

20. Fig. 6 shows the construction for finding the shadow of a point *a* on H.

21. Fig. 7 shows the construction for finding the shadow of a point *a*, which is at an equal distance from both V and H. Its shadow, therefore, falls on the line of intersection of V and H.

22. Fig. 8 shows the construction for finding the imaginary shadow of the point *a*, situated as in Fig. 5, that is, nearer the V plane than the H. The actual shadow would in this case fall on V, but it is sometimes necessary to find its imaginary shadow on H. The method of determining this is similar to that explained in connection with Fig. 5.

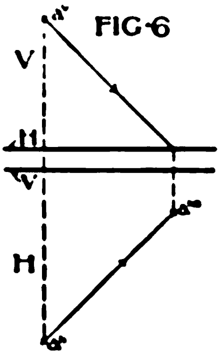

FIG·5

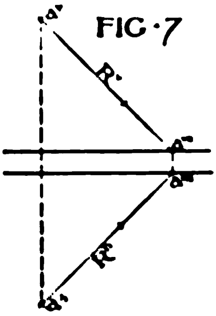
Draw R^v until it meets the ground line of H.

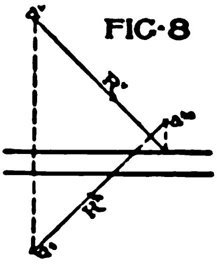
Erect a perpendicular at this point of intersection.

Draw R^h.

The intersection a^{hs}, of the latter and the perpendicular, is the required imaginary shadow on H of the point *a*.


FIG·6


FIG·7

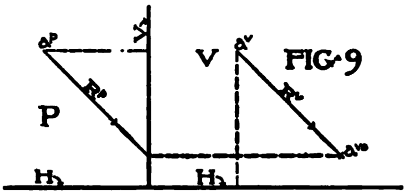

FIG·8

23. The actual shadow of a given point, with reference to the two co-ordinate planes, will fall on the nearer co-ordinate plane.

24. Fig. 9 shows the construction for finding the shadow of

a given point *a* on the V plane when the vertical and profile projections of the point are given.

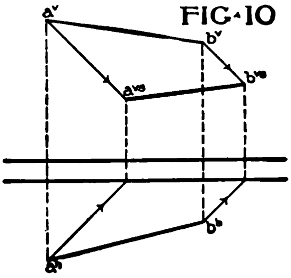
25. In general, *the finding of the shadow of a given point on a given plane is the same as the finding of the point of intersection of its umbra with that plane.* To obtain this, *one projection of the given plane must be a line and that is used as the ground line.* It is necessary to have a ground line to which is drawn the projection of the ray of light, in order that we may know that the ray of light has pierced the given plane.

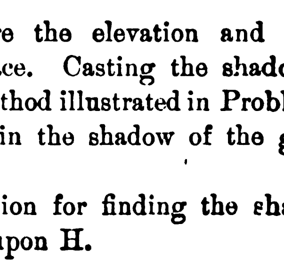

FIG·9

SHADOWS OF LINES.

26. Problem II. To find the shadow of a given line on a given plane.

A straight line is made up of a series of points. Rays of light passing through all of these points would form a plane of light. The intersection of this plane of light with either of the co-ordinate planes would be the shadow of the given line on that plane. This shadow would be a straight line because two planes always intersect in a straight line. This fact, and the fact that a straight line is determined by two points, enables us to cast the shadow of a given line by simply casting the shadows of any two points in the line and drawing a straight line between these points of shadow.

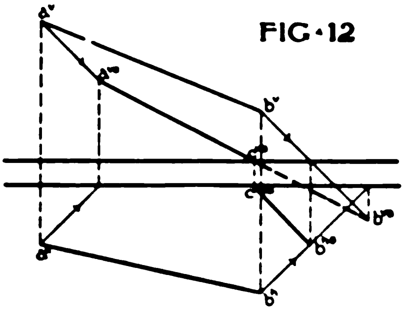

FIG·10

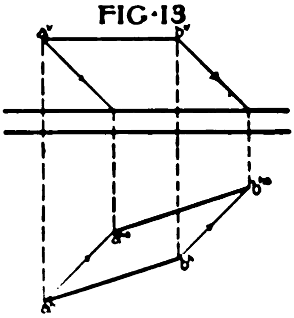

FIG·11

In Fig. 10, a^vb^v and a^hb^h are the elevation and plan respectively of a given line ab in space. Casting the shadow of the ends of the line a and b by the method illustrated in Problem 1 and drawing the line $a^{vs}b^{vs}$, we obtain the shadow of the given line ab on V.

27. Fig. 11 shows the construction for finding the shadow of the line ab when the shadow falls upon H.

28. Fig. 12 shows the construction for finding the shadow of a line so situated that part of the shadow falls upon V and the remainder on H. To obtain the shadow in such a case, it must be found *wholly on either one of the co-ordinate planes*. In Fig. 12, it has been found wholly on V, a^{vs} being the actual shadow of that end of the line, and b^{vs} being the imaginary shadow of the end b on V. Of the line $a^{vs}b^{vs}$ we use only the part $a^{vs}c^{vs}$, that being the shadow which actually falls upon V.

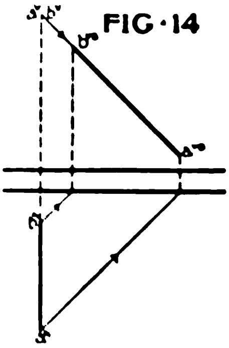

FIG·12


FIG·13

The point where the shadow leaves V and the point where it begins on H are identical, so that the beginning of the shadow on H will be on the lower ground line directly below the point c^{vs}; c^{hs} will then be one point in the shadow of the line on H, and casting the shadow of the end b we obtain b^{hs}. The line $c^{hs}b^{hs}$, drawn between these points, is evidently the required shadow on H.

29. Another method of casting the shadow of such a line as ab is to determine the entire shadow on each plane independently. This will cause the two shadows to cross the ground lines at the same point c, and of these two lines of shadows we take only the actual shadows as the required result. This method involves unnecessary construction, but should be understood.

30. Fig. 13 shows the construction of the shadow of a given line on a plane to which it is parallel. It should be noted that *the shadow in this case is parallel and equal in length to the given line.*


FIG·14

31. Fig. 14 shows the construction of the shadow of a given line on a plane to which the given line is perpendicular. It is to

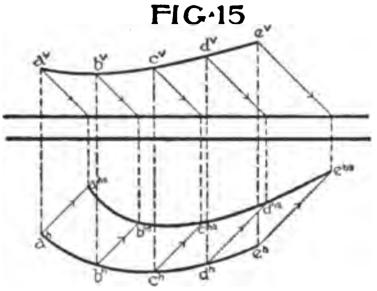
be noted that *the shadow coincides in direction with the projection of the ray of light on that plane*, and is equal in length to the diagonal of a square of which the given line is one side.

32. Fig. 15 shows the construction for finding the shadow of a curved line on a given plane. Under these conditions we find, by Problem 1, the shadows of a number of points in the line—the greater the number of points taken the more accurate the resulting shadow. The curve drawn through these points of shadow is the required shadow.

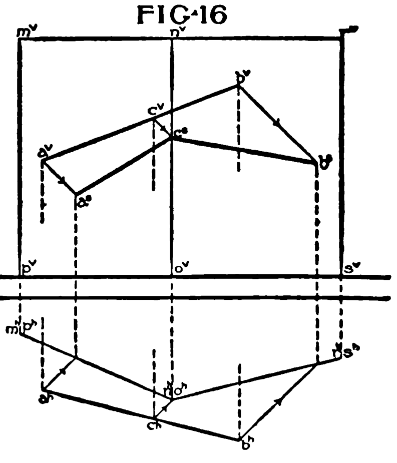
33. In Fig. 16 the given line *ab* is in space and the problem is to find its shadow on two rectangular planes *mnop* and *nrso*, both perpendicular to H.

Consider first the shadow of *ab* on the plane *mnop*. The edge *no* is the limit of this plane on the right. Therefore from the point n^h draw back to the given line the projection of a ray of light. This 45° line intersects the given line at c^h. It is evident that of the given line *ab*, the part *ac* falls on the plane *mnop* and the remainder, *cb*, on the plane *nrso*.

FIG·15



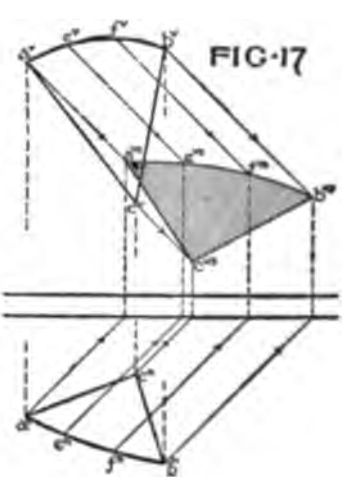
FIG·16



To find the shadow of *ac* on the left-hand plane we must first determine our ground line. *The ground line will be that projection of the plane receiving the shadow which is a line.* In this example the vertical projection of the plane *mnop* is the rectangle $m^v n^v o^v p^v$. This projection cannot, therefore, be used as a GL. The plan, or H projection, of this plane is, however, a line $m^h n^h$. This line, therefore, will be used as the ground line for finding the shadow of *ac* on *mnop*.

We find the shadow of a to be at a^s and the shadow of c at c^s, Problem I. The line a^sc^s is, therefore, a part of the required shadow. The remaining part, c^sb^s is found in a similar manner.

34. The above illustrates the method of determining the GL when the shadow falls upon some plane other than a co-ordinate plane. In case neither projection of the given plane is a line, the shadow must be determined by methods which will be explained later.


FIG·17

SHADOWS OF PLANES.

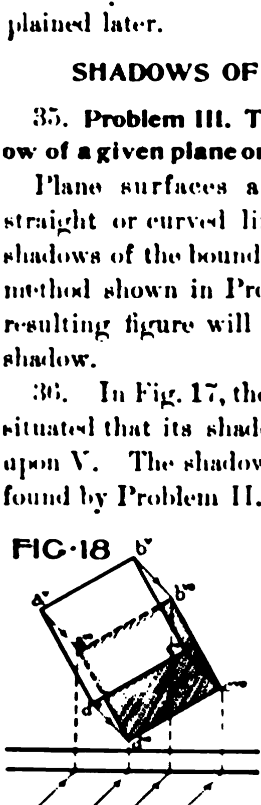
35. **Problem III. To find the shadow of a given plane on a given plane.**

Plane surfaces are bounded by straight or curved lines. Find the shadows of the bounding lines by the method shown in Problem II. The resulting figure will be the required shadow.

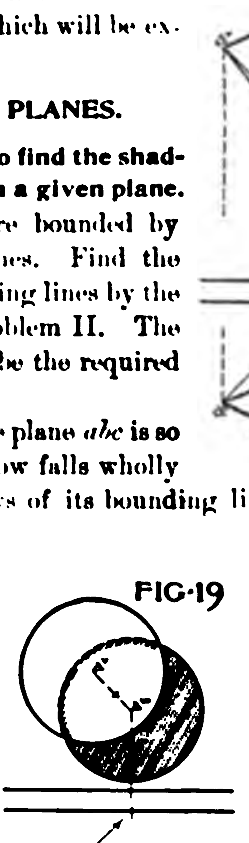
36. In Fig. 17, the plane abc is so situated that its shadow falls wholly upon V. The shadows of its bounding lines, ab, bc, ca have been found by Problem II.

That portion of the shadow hidden by the plane in elevation is cross-hatched along the edge of the shadow only. This method of indicating actual shadows which are hidden by the object is to be followed in working out the problems of the examination plates.

FIG·18



FIG·19



37. Fig. 18 shows the construction of the shadow of a plane on the co-ordinate plane to which the given plane is parallel. (In this case the vertical plane.) It is to be observed that *the shadow is equal in size and shape to the given plane.*

Fig. 19 shows that, in case of a circle parallel to one of the co-ordinate planes, it is only necessary to find the shadow of the center of the circle and with that point as a center construct a circle of the same radius as that of the given circle.

NOTE:

39. Any point, line, or plane lying in a surface is considered to be its own shadow on that surface.

40. A *surface parallel to a ray of light is considered to be in* **shade.**

41. In the above problems the points, lines and planes have been given in vertical and horizontal projection. The methods for finding their shadows are, in general, equally true when the points, lines and planes are given by vertical and profile projection or horizontal and profile projection.

SHADOWS OF SOLIDS.

42. The methods for finding the shadows of solids vary with the nature of the given solid. The shadows of solids which are bounded by plane surfaces, none of which are parallel, or perpendicular, to the co-ordinate planes, can in general, be found only by finding the shadows of all the bounding planes. These will form an enclosed polygon, the sides of which are the shadows of the shade lines of the object, and the shade lines of the solid are determined in this way. The following is an illustration of this class of solids.

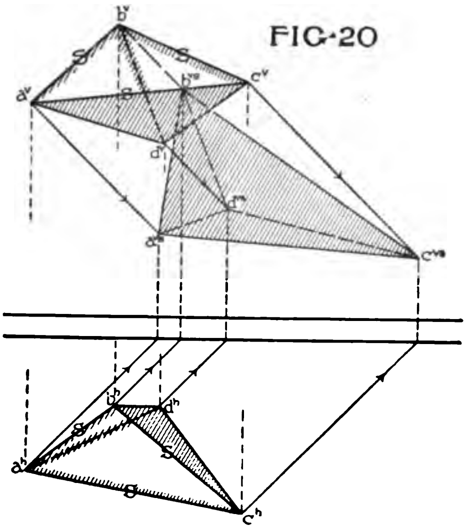


FIG-20

43. **Problem IV. To find the shade and shadow of a polyhedron, none of whose faces are parallel or perpendicular to the co-ordinate planes.**

Fig 20 shows a polyhedron in such a position and of such a shape that none of its faces are perpendicular or parallel to the co-ordinate planes. It is impossible, therefore, to apply to this figure the projections of the rays of light and determine what faces are in light and what in shade. Consequently we cannot determine the shade line whose shadows would form the shadow of the object.

Under these circumstances we must cast the shadows of all the boundary edges of the object. Some of these lines of shadow will form a polygon, the others will fall inside this polygon. The edges of the object whose shadows form the bounding lines of the polygon of shadow are the shade lines of the given object. Knowing the shade lines, the light and shaded portions of the object can now be determined, since these are separated by the shade lines.

In a problem of this kind care should be taken to letter or number the edges of the given object.

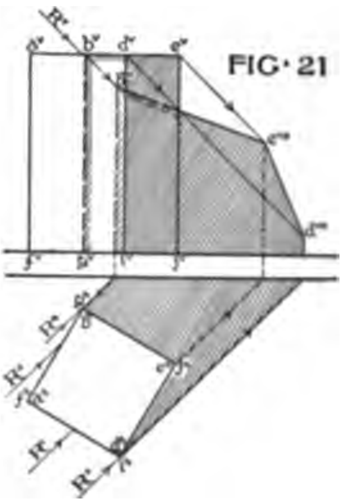
44. The edges of the polyhedron shown in Fig. 20 are ***ab***, *bc*, *cd*, *da*, *ac* and *bd*.

Cast the shadows of each of these straight lines by the method shown in Problem II.

We thus obtain a polygon bounded by the lines $b^{vs}c^{vs}$, $c^{vs}a^{vs}$, $a^{vs}b^{vs}$, and this polygon is the shadow of the given solid.

The lines which cast these lines of shadow, $b^{vs}c^{vs}$, $c^{vs}a^{vs}$, and $a^{vs}b^{vs}$ are therefore the shade lines of the object, and, therefore, the face *abc* is in light and the faces *abd*, *bcd* and *acd* are in shade.

The shadows of the edges *bd*, *dc*, and *ad* falling within the polygon, indicate that they are not shade lines of the given object, and, therefore, they separate two faces in shade or two faces in light. In this example *bd* and *cd* separate two dark faces.



FIG·21

In architectural drawings the object usually has a sufficient number of its planes perpendicular or parallel to the co-ordinate planes, to permit its shadow being found by a simpler and more direct method than the one just explained.

45. **Problem V. To find the shade and shadow of a prism on the co-ordinate planes, the faces of the prism being perpendicular or parallel to the V and H planes.**

In Fig. 21 such a prism is shown in plan and elevation. The elevation shows it to be resting on H, and the plan shows it to be situated in front of V, its sides making angles with V. Since its top and bottom faces are parallel to H and its side faces perpendicular to that plane, we can apply the projections of the rays of light to the plan and determine at once which of the side faces are in light and which in shade. The projections of the rays R^1 and R^2 show that the faces *abgf* and *adif* receive the light directly, and that the two other side faces do not receive the rays of light and are, therefore, in shade. The edges *bg* and *di* are two of the shade lines. R^3 and R^4 are the projections of the rays which are tangent to the prism along these shade lines.

Applying the projection R^5 in the elevation makes it evident that the top face of the prism is in light and the bottom face is in shade since the prism rests on H. This determines the light and shade of all the faces of the prism, and the other shade lines would therefore be *bc* and *cd*.

Casting the shadow of each of these shade lines, we obtain the required shadow on V and H.

It is evident that the shadows of the edges *bg* and *di* on H will be 45° lines since these edges are perpendicular to H (§ 31) Also, their shadows on V will be parallel to the lines themselves since these shade lines are parallel to V. (§ 30)

46. In general, to find the shadow of an object whose planes are parallel or perpendicular to H or V:

(1) Apply to the object the projections of the ray of light to determine the lighted and shaded faces.

(2) These determine the shade lines.

(3) Cast the shadows of these shade lines by the method followed in Problem II.

47. **Problem VI. To find the shade and shadow of one object on another.**

In Fig. 22 is shown in plan and elevation a prism B, resting on H and against V. Upon this prism rests a plinth A: To find the shadow of the plinth on the prism and the shadow of both on the co-ordinate planes. Since these objects have their faces either perpendicular to, or parallel to, the co-ordinate planes, we can determine immediately the light and shade faces and from them the shade lines.

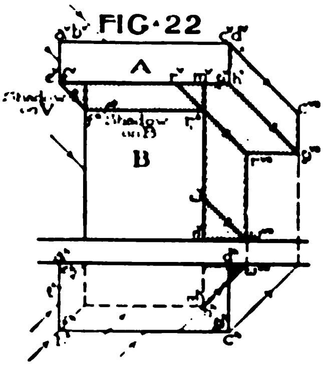
48. Considering first the plinth A, it is evident that its top, left-hand and front faces will receive the light, that the lower and right-hand faces will be in shade. The back face resting against the V plane will be its own shadow on V. (§ 39) The shade lines of A will be, therefore, ef, fg, gc and cd.

Cast the shadows of these lines. A rests against V and part of its shadow will fall on V; also, since it rests on B the remainder will fall on B. Begin with the point e, one end of the shade line; this point, lying in V, is its own shadow on V. (§ 39).

The line ef being perpendicular to V, its shadow, or as much of its shadow as falls on V, will be, therefore, a 45° line drawn from e^v. The point t^h, in plan, shows the amount of the line ef which falls on V, the rest tf falls on the side face of the prism, and this shadow is not visible in elevation or plan.

The shadow of the point f evidently falls on the edge of the prism at f^h, see plan. This point f is one end of the shade line fg, therefore f is one point in the shadow of fg on the front face of the prism B. The line fg being parallel to this front face, its shadow will be parallel to the line, therefore from the point f^s we draw the horizontal line $f^s r_1^s$.

FIG·22



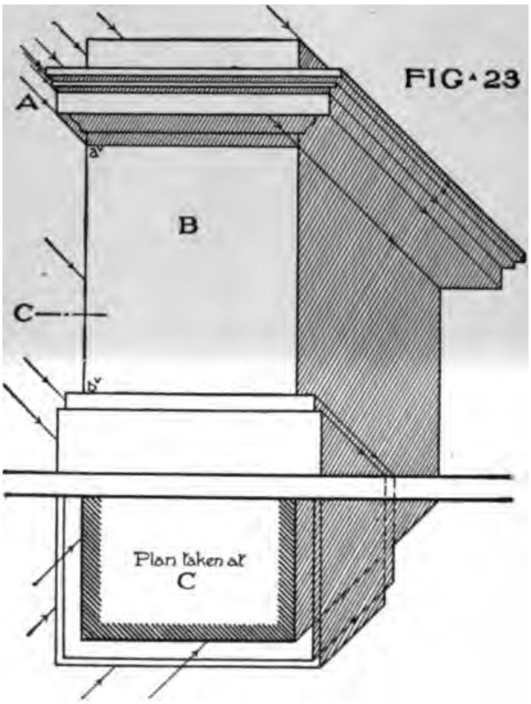
If from the point r_1^s we draw the projection of a ray of light back to the shade line $f^v g^v$ we determine the amount of the line casting a shadow on the front face of B, that is to say, the distance $f^v r^v$. The shadow of the remainder, $r^v g^v$, falls beyond the prism on the V plane, and is evidently the line $r^{sv} g^{sv}$. Thus the shadow of the shade line from e to g has been determined.

The next portion of the shade line, gc, is a vertical line and we have already obtained the shadow of the end g. Since it is a vertical line its shadow on V will be vertical and equal in length. Therefore draw $g^{sv} c^{sv}$.

There remains now only the edge, cd, of which to cast the shadow. The end d being in the V plane must be its own shadow on that plane. (§ 39) We have already found the shadow of the other end o, at o^{vs}. Therefore d^vc^{vs} is the shadow of do and completes the outline of the shadow of the plinth.

It will be noted that d^vc^{vs} is a 45° line, which would be expected since the edge do is perpendicular to V.

49. Considering next the prism B, we find by applying the projections of the rays of light to the plan, that the front and left-hand faces are in light, and that the right-hand face is in shade. Therefore the only shade line in this case is the edge mn. The upper part of this, $m^vr_1^s$ is in the shade of the plinth and therefore cannot cast any shadow.



FIG·23

It is to be noted that the ray of light from the point r^v in the plinth A passes through the point r_1^s in the shade line of the prism B. In finding the shadow of this point at r^{vs} we therefore have found the shadow also of one end of the shade line nr. Since nr is vertical, its shadow will be vertical on V. Therefore draw $r^{vs}w^{vs}$. This line completes the shadow of the two objects upon the V plane.

From the point of shadow w^{vs} draw the V projection of the ray back to the line $n^v r_1^v$. This shows how much of the total line nr falls upon V, and how much upon H.

The shadow on H of the portion nw will be a 45° line since nw is perpendicular to H. The point n being in the H plane is its own shadow on that plane.

It is to be noted that the point w^{hs} is on the perpendicular directly below w^{vs}.

50. **Problem VII. To find the shade and shadow of a pedestal.**

Fig. 23 shows the plan and elevation of a pedestal resting on the ground and against a vertical wall. This is an application of the preceding problem in finding the shades and shadows of one object upon another. The profile of the cornice moulding on the left, at A, can be used as a profile projection in finding the shadows of those mouldings on themselves and upon the front face B, of the pedestal. By drawing the profile projections of the rays tangent to this profile of mouldings, it will be seen what edges are shade lines and where their shadows will fall on the surface of B. The line $a^v b^v$ can be assumed to be the profile projection of the front face of B, and being a line is used as the *ground line* for finding the shadow on B. As this collection of mouldings is parallel to the V plane their shades and shadows will be parallel in the elevation. Otherwise the shadows of this pedestal are found in a manner similar to the preceding problem.

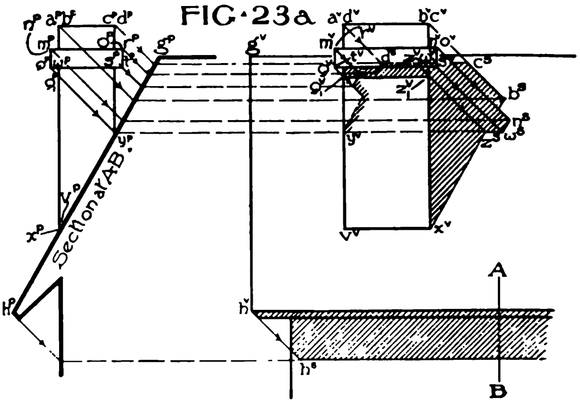
51. **Problem VIII. To find the shadow of a chimney on a sloping roof.**

Fig. 23a shows in elevation and side elevation the chimney and roof. The chimney itself being made up of prisms with their planes parallel or perpendicular to the V plane, its light and shade faces can be determined at once, as in Problem V. It will be evident from the figure that the top, front, and left-hand faces of the chimney in elevation will be in light. The remaining faces will be in shade, and the shade lines will be therefore, yd, on the back, dc, ch, and bx. Not all of bx and yd will cast shadows for the shadow of the flat band, running around the upper part of the chimney, will cause a portion of these two lines yd and bx to be in shadow and such portions cannot cast any shadows. (See Problem VI—the shadow of one object upon another.)

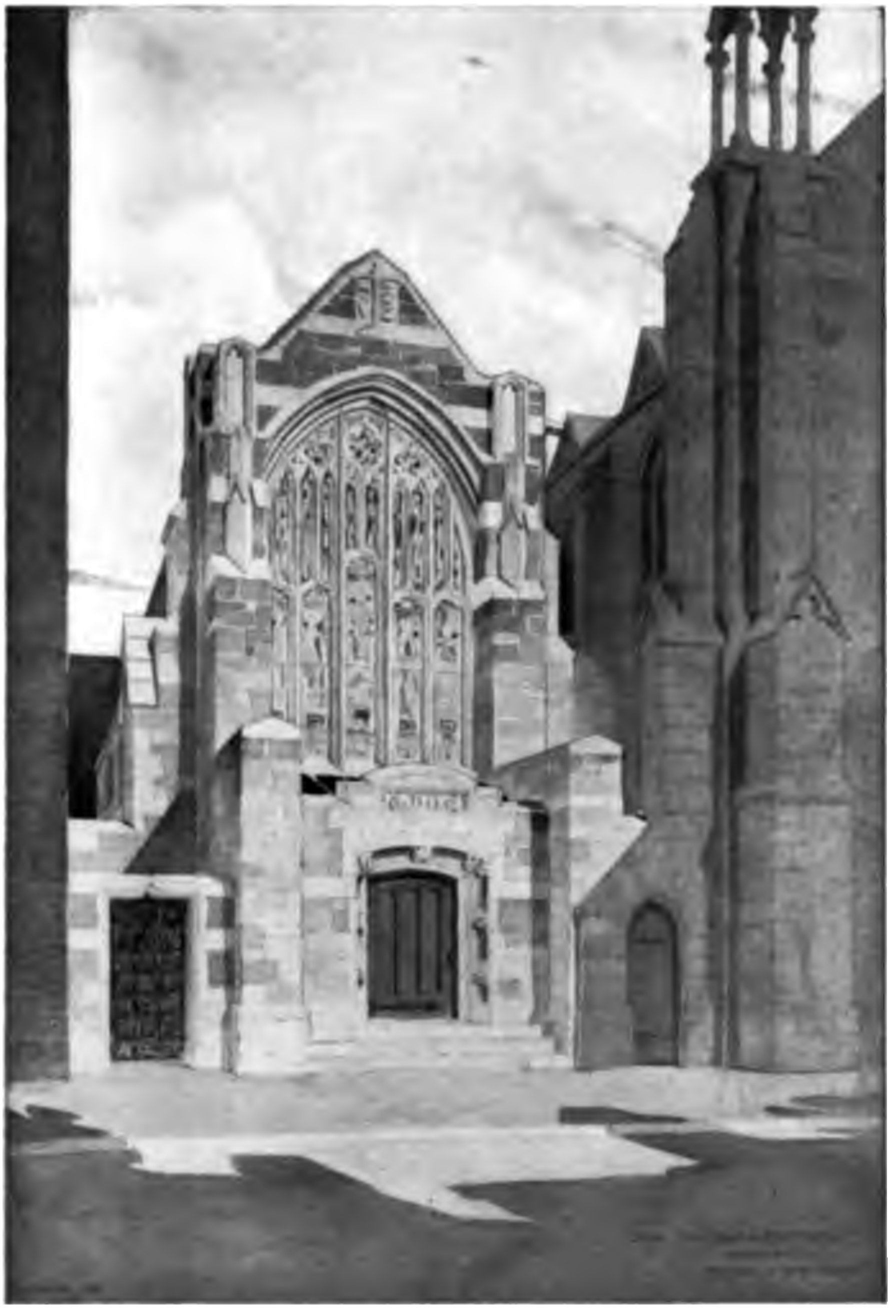
It is evident that, to find the shadow of the shade line of the chimney upon the sloping roof, *we must have for a ground line a projection of the roof which is a line.* The roof in elevation is projected as a plane, but the side elevation (or in other words the profile projection) shows the roof projected as a line in the line h^pg^p. This line will be then the ground line for finding the shadow of any point in the chimney on the roof. For example, take the point b. If we draw the profile projection of the ray through the point b^p until it intersects the ground line h^pg^p, and draw from this point of intersection a horizontal line across until it intersects the vertical projection of the ray drawn through b^v, this last point of intersection b^s, will be the shadow of b upon the roof.

In a similar manner the shadow of any point or line in the chimney can be found on the roof.

FIG·23a



Before completing the shadow of the chimney upon the roof let us consider the shadow of the flat band on the main part of the chimney. This band projects the same amount on all sides. On the left-hand and front faces it will cast a shadow on the chimney proper. Only the shadow on the front face will be visible in elevation. To find this, draw the profile projection of the ray through the point q^p until it intersects the line a^pv^p, the profile projection of the front face. From this point $q_1{}^p$ draw a horizontal line across until it meets the vertical projection of the ray drawn through q^v. From q^v, the shadow of q^vw^v on the front face will be parallel to q^vw^v, for that line is parallel to that face; therefore draw $q_1{}^vz_1{}^v$.



GRACE MEMORIAL CHAPEL, CHICAGO, ILLINOIS

[illegible]

[illegible]

[illegible]

Now that the visible shadows on the chimney itself have been determined, its shadow on the roof can be found as explained in the first part of this problem. A portion of the shade line of the flat band, $z^v w^v$, $w^v n^v$, etc., falls beyond the chimney on the roof, as shown by the line $z^s w^s$, $w^s n^s$, etc.

52. It is to be noted in the shadow on the roof that:

(a) The shadows of the vertical edges of the chimney *make angles with a horizontal line equal to the angle of the slope of the roof* (in this case 60°).

(b) The horizontal edges which are parallel to V cast shadows which *are parallel to these same edges* in the chimney.

(c) The horizontal edges which are perpendicular to V cast shadows which *make angles of 45° with a horizontal line*.

53. The above method would also be used in finding shadows on sloping surfaces when the objects are given in elevation and side elevation, as, for example, a dormer window.

54. **Problem IX. To find the shades and shadows of a hand rail on a flight of steps and on the ground.**

Fig. 24 shows the plan and elevation of a flight of four steps situated in front of a vertical wall, with a solid hand rail on either side, the hand rails being terminated by rectangular posts. At a smaller scale is shown a section through the steps and the slope of the hand rail.

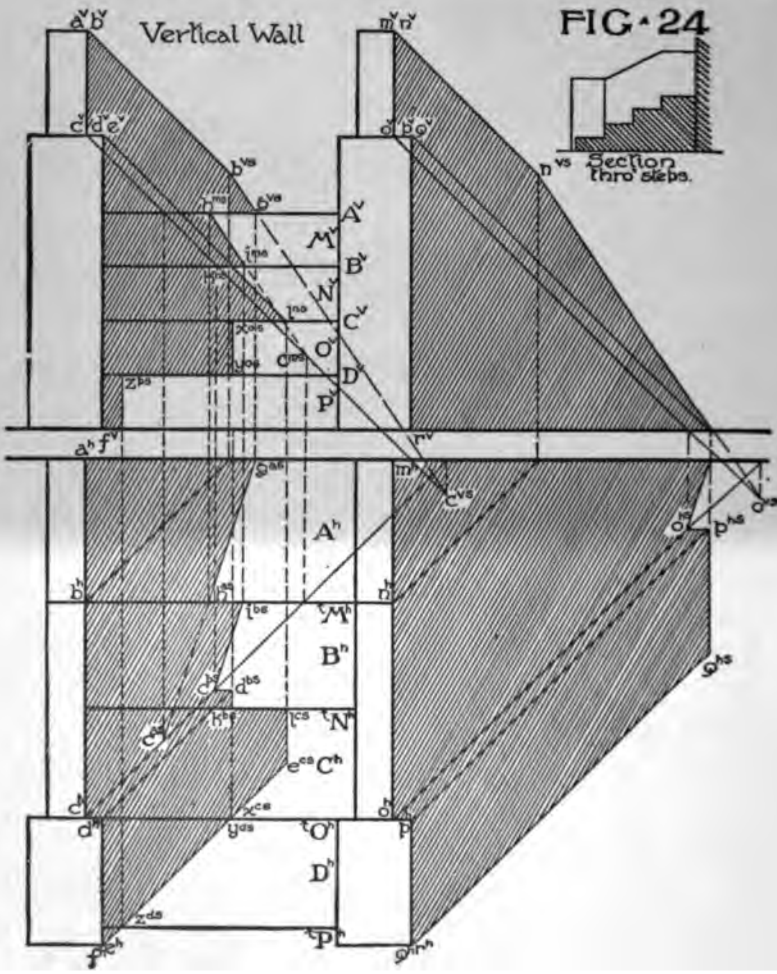
This problem amounts to finding the shadow of a broken line, that is to say, the shade line, on a series of planes. Each of the planes requires its own ground line, which in the case of each plane will be that projection of the plane which is a line. Since the planes of the steps and rails, with one exception, are all parallel or perpendicular to the co-ordinate planes we can determine at once what planes are in light and what in shadow and thus determine the shade line.

55. An inspection of the figure will make it evident that the "treads" of the steps, A, B, C, D and the "risers," M, N, O, P are all in light. Of the hand rail it will be evident also that the left-hand face, the top, and the front face of the post are in light. The remaining faces are in shade. This is true of both rails; therefore, in one case we must find the shadow of a broken line, *abcdef* on the vertical wall and on the steps, and then find the shadow of

the broken line *mnopqr* on the vertical wall and on the ground.

56. Beginning with the shadow of the left-hand rail, the shadow of the point *a* on the wall is evidently a^v, since *a* lies in the plane of the vertical wall (§ 39)

The line *ab* is perpendicular to V hence its shadow will be a


FIG·24

45° line, the point b^{vs} being found by Problem I. The shadow of *bc*, the sloping part of the rail, will fall partly on the vertical wall and partly on the treads and risers. We have already found the shadow of the end *b* on V in the point b^{vs}. The shadow of *c* on V, found by Problem I will be c^{vs}. The portion $b^{vs}g^{vs}$ is the part of the shadow of this line bc that actually falls on the wall, the steps preventing the rest of the line from falling on V.

The line of shadow now leaves the vertical wall at the point g^{as}, directly below g^{vs}. The *ground line* for finding the shadow on this upper tread will evidently be the line A^v, since *that line is the projection of this tread which is a line*. The horizontal projection of the tread is a plane between the lines a^hm^h and b^hn^h. We have now determined our GL and we also have one point, g^{as} in the required shadow on the upper tread A. It remains to find the shadow of the end c on A. Draw the projection of the ray through c^v until it meets the line A^v, drop a perpendicular until it intersects the projection of the ray drawn through c^h at the point c^{as}. The point c^{as} lies on the plane A extended. Draw the line $g^{as}c^{as}$. The portion $g^{as}h^{as}$ is the part actually falling on the tread A.

From this point h, the shadow leaves tread A and falls on the upper riser M. The shadow will now show in elevation and begin at the point h^{ms} directly above the point h^{as}.

We now determine a new *ground line* and *it will be that projection of the upper riser M, which is a line*. The vertical projection of M is a plane surface between the lines A^v and B^v. The H projection of the riser M is the line M^h, therefore this is our GL, and we find the shadow on M in a manner similar to the finding of the shadow on A, just explained. Bear in mind that we have one point h^{ms}, already found in this required shadow on M.

In a like manner the shadow of the remainder of the shade line is found until the point f is reached, which is its own shadow on the ground. (39)

57. It is to be noted that, since the plane of the vertical wall and the planes of the risers are all parallel, the shadows on these surfaces of the same line are all parallel. For a similar reason, the shadows of the same line on the treads and ground will be parallel. This fact serves as a check as to the correctness of the shadow.

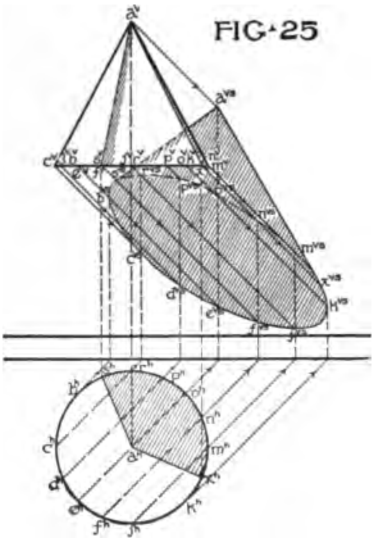
Also note in the plan that the shadow of the vertical edge ef of the post is a continuous 45° line on the ground, the lower tread D, and on the next tread C, above. *While this line of shadow on the object is of course in reality a broken line, it appears in horizontal projection on plan as a continuous line.*

The shadow of the shade line of the right-hand rail is simply the shadow of a broken line on the co-ordinate planes, and requires no detailed explanation.

58. **Problem X. To find the shade and shadow of a cone.**

The finding of the shadow of a cone is, in general, similar to finding the shadow of the polyhedron none of whose planes are perpendicular or parallel to the co-ordinate planes.

It is impossible to determine at the beginning, the shade elements of the cone whose shadows give the shadow of the cone, and we first find the shadow of the cone itself and from that determine its shade elements: that is to say we reverse the usual process in determining the shadow of an object.

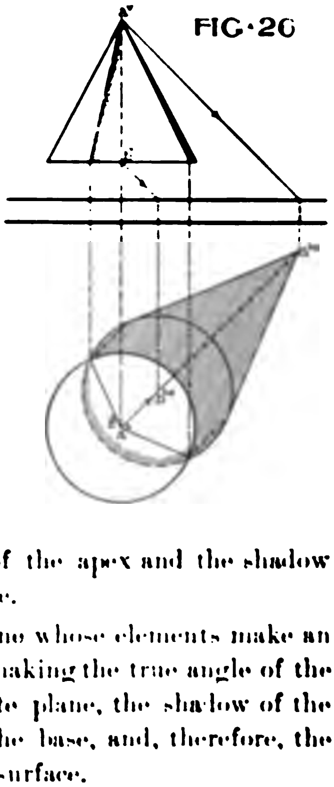

FIG·25

59. Fig. 25 shows, in elevation and plan, a cone whose apex is a and whose base is $bcde$, etc. The axis is perpendicular to H and the cone is so situated that its shadow falls entirely on the V plane.

60. It is evident that the shadow of the cone must contain the shadow of its base and also the shadow of its apex. Therefore, if we find the shadow of its apex by Problem I, and then find the shadow of its base by Problem III and draw straight lines from the shadow of the apex tangent to the shadow of the base, the resulting figure will be the required shadow of the cone.

61. This has been done in Fig. 25, in which a^{vs} is the shadow of the apex a. The ellipse $b^{vs}c^{vs}d^{vs}$, etc., is the shadow of the base, found by assuming a sufficient number of points in the perimeter of the base and finding their shadows. The ellipse drawn through these points of shadow is evidently the shadow of the base. From the point a^{vs} the straight lines $a^{vs}s^{vs}$ and $a^{vs}x^{vs}$ were drawn tangent to the ellipse of the shadow. This determined the shadow on V of the cone. The lines $a^{vs}s^{vs}$ and $a^{vs}x^{vs}$ are

the shadows of the shade elements of the cone. It remains to determine these in the cone itself. Any point in the perimeter of the shadow of the base must have a corresponding point in the perimeter of the base of the cone, and this can be determined by drawing from the point in the shadow the projection of the ray back to the perimeter of the base. Therefore if we draw 45°-lines from the point x^{vs} and s^{vs} back to the line $c^v m^v$ in the elevation, we determine the points x^v and s^v. The lines drawn from these points to the apex a^v are the shade elements of the cone. They can be determined in plan by projection from the elevation. The cross-hatched portion of the cone indicates its shade. It will be observed that but little of it is visible in elevation.



FIG·26

62. When the plane of the base of the cone is parallel to the plane on which the shadow falls, as in Fig. 26, the work of finding its shade and shadow is materially reduced, for the shadow of the base can then be found by finding the shadow of the center b of the base and drawing a circle of the same radius. (See Fig. 19.)

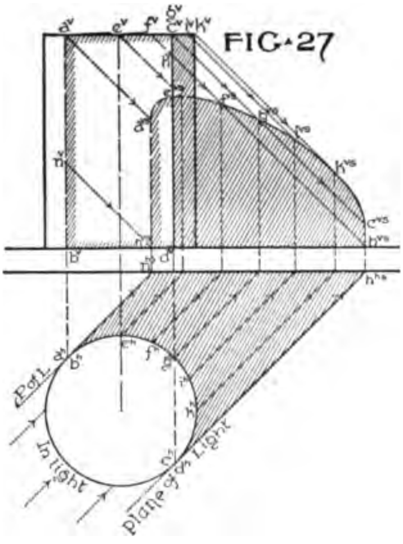
63. In general, to find the shadow of any cone, find the shadow of its apex, then the shadow of its base, draw straight lines from the former, tangent to the latter. Care should be taken, however, that both the shadow of the apex and the shadow of the base are found on the same plane.

64. It is to be noted that in a cone whose elements make an angle of *35°-15'-52" or less*, that is, making the true angle of the ray of light or less, with the co-ordinate plane, the shadow of the apex will fall within the shadow of the base, and, therefore, the cone will have no shade on its conical surface.

65. **Problem XI. To find the shade and shadow of a right cylinder.**

In Fig. 27 is shown the plan and elevation of a right cylinder resting on H. The rays of light will evidently strike the top of the cylinder and the cylindrical surface shown in the plan between the points b^h and d^h. At these points, the projections of the ray of light are tangent, and these points in plan determine the shade elements of the cylinder in elevation. These shade elements, $a^v b^v$ and $c^v d^v$, are the lines of tangency of planes of light tangent to the cylinder. The shadow of these lines ab and cd, together with the shadow of the arc $aefg$, etc., of the top of the cylinder, form the complete shadow of the cylinder.

Since ab and cd are perpendicular to H, as much of their shadow as falls upon the H plane will be 45° lines drawn from b^h and d^h respectively. In one case the amount is the line $n^v b^v$, in the other $h^v d^v$. The remainder of the lines will fall upon V and this is found by Problem II. These shadows on V will evidently be parallel to $a^v n^v$ and $c^v h^v$.



FIG·27

The shadow of the shade line $aefg$, etc., on V will be found by Problem II. (§ 32)

66. If the cylinder had been placed so that the whole of its shadow fell upon H, the shadow of the shade line of the top would have been found by finding the shadow of the center of the circle and drawing a circle of the same radius, since the plane of the top is parallel to H. (§ 38)

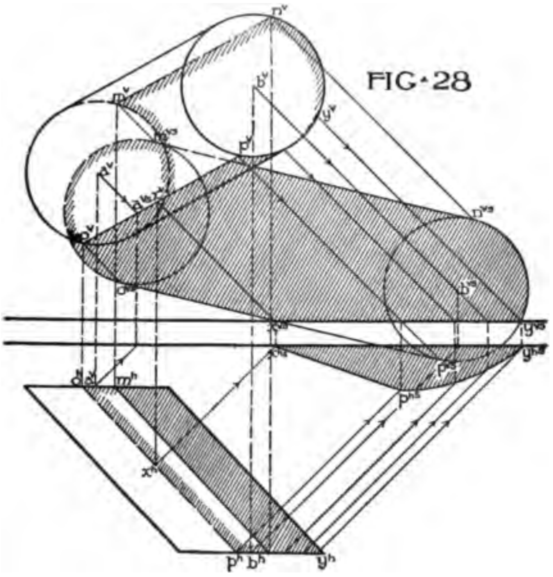
67. **Problem XII. To find the shade and shadow of an oblique cylinder.**

In Fig. 28 is shown the plan and elevation of an oblique cylinder whose vertical section is a circle.

68. Unlike the right cylinder we cannot apply to the plan or elevation the projections of the ray and determine at once the location of the shade elements. To find the shadow of an oblique cylinder we proceed in a manner similar to finding the shade and shadow of a cone; that is, we find first the shadow of the cylinder and from that shadow determine the shade elements.

69. In Fig. 28 the top and base of the oblique cylinder have been assumed, for convenience, parallel to one of the co-ordinate planes. The shadow of the cylinder will contain the shadows of the top and base, hence if we find their shadows and draw straight lines tangent to these shadows, we shall obtain the required shadow of the cylinder.

70. In Fig. 28, the top and bottom being circles, the shadows of their centers *a* and *b* are found at a^{vs} and b^{vs}, and circles of the same radius are drawn. Then the lines $m^{vs}n^{vs}$ and $o^{vs}p^{vs}$ are drawn tangent to these circles. The resulting figure is the required shadow wholly on V. Projections of the ray are then drawn back from m^{vs}, n^{vs}, o^{vs} and p^{vs} respectively to the perimeter of the top and base. Their points of intersection m^v, n^v, o^v and p^v are the ends of the shade elements in the elevation. They can be found in plan by projection. An inspection of the figure will make it evident what portions of the cylindrical surface between these shade elements will be light and what in shade.

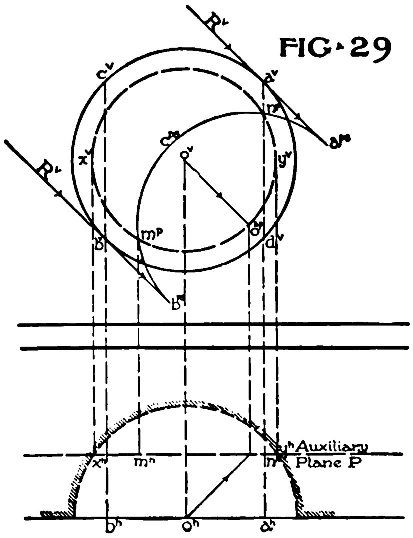

FIG·28

71. In this problem it will be seen that the shadow does not fall wholly upon V. The shadow leaves V at the points x^{vs} and y^{vs} and will evidently begin on H at points directly below, as x^{hs} and y^{hs}.

If projections of the ray are drawn back to the object in plan and elevation from these points, x^{vs}, y^{vs}, x^{hs}, and y^{hs}, they will determine the portion of the shade line which casts its shadow on H. It is evident that in this particular object it is that portion of the shade line of the top between the points p and y and the portion xp, of one of the shade elements. The shadows of these lines are found on H by Problem II.

USE OF AUXILIARY PLANES.

72. In finding shadows on some of the double-curved surfaces of revolution, such as the surface of the spherical hollow, the scotia and the torus, we can make use of auxiliary planes to advantage, *when the plane of the line whose shadow is to be cast is parallel to one of the co-ordinate planes.*


FIG·29

73. Problem XIII. To find the shadow in a spherical hollow.

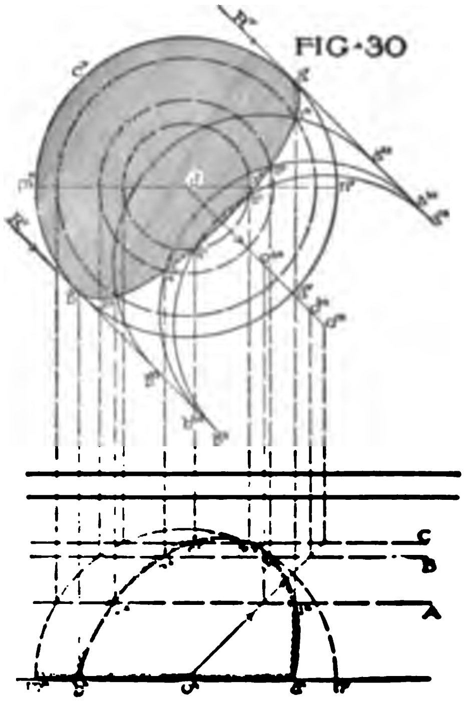
Fig. 29 shows in plan and elevation a spherical hollow whose plane has been assumed parallel to V.

Applying to the elevation, the projections of the ray R, we determine the amount of the edge of the hollow which will cast a shadow on the spherical surface inside. The points of tangency a^v and b^v are the limits of this shade line $a^vc^vb^v$. The remaining portion of the line $a^vd^vb^v$ is not a shade line since the light would reach the spherical surface adjacent to it and also reach the plane surface on the other side of $a^vd^vb^v$ outside the spherical hollow.

We must now cast the shadow of the line $a^vc^vb^v$ on the spherical surface of the hollow, and having no ground line, (since neither the V nor the H projection of the spherical hollow is a line,) we use auxiliary planes.

If we pass through the spherical hollow, parallel to the plane of the line acb (in this case parallel to V) an auxiliary plane P, it will cut on the spherical surface a line of intersection xy; in elevation this will show as a circle $x^v y^v$, whose diameter is obtained from the line $x^h y^h$ in the plan. This line of intersection will show in plan as a straight line, $x^h y^h$.

Cast the shadow of the line acb on this auxiliary plane P. This is not difficult because the plane P was assumed parallel to acb, and in this particular case, $a^v c^v b^v$ is the arc of a circle. To cast its shadow on P it is only necessary to cast the shadow of its center o^v, using the line P as a *ground line* and to draw an arc of same length and radius. We thus obtain the arc $a^{ps} c^{ps} b^{ps}$. This is the shadow of the shade line of the object on the auxiliary plane P. It will be noted that this shadow $a^{ps} c^{ps} b^{ps}$ crossed the line of intersection, made by P with the spherical surface, at the two points m^p and n^p. In plan these points would be m^h and n^h which are two points in the required shadow on the spherical surface for they are the shadows of two points in the shade line acb and they are also on the surface of the spherical hollow since they are on the line of intersection xy which lies in that spherical surface. With one auxiliary plane we thus obtain two points in the shadow of the hollow.


FIG·30

In Fig. 30 a number of auxiliary planes have been used to obtain a sufficient number of points, 1, 2, 3, 4, etc., of the shadow, to warrant its outline being in elevation and plan with accuracy. The shadow in plan is determined by projection from the shadow in elevation, which is found first.

74. The separate and successive steps in this method of determining the shadow of an object by the use of auxiliary planes are as follows:

1. Determine the shade line by applying to the object the projections of the ray of light.
2. Pass the auxiliary planes through the object parallel to the plane of the shade line.
3. Find the line of intersection which each auxiliary plane makes with the object.
4. Cast the shadow of the shade line on each of the auxiliary planes.
5. Determine the point or points where the shadow on each auxiliary plane crosses the line of intersection made by that plane with the object.
6. Draw a line through these points to obtain the required shadow.

75. **Problem XIV. To find the shadow on the surface of a scotia.**

This problem is similar in method and principle to that for finding the shadow on a spherical hollow. Neither the H or V projection of the surface of the scotia is a line, and we therefore must resort to some method other than that generally used. The following is the most accurate and convenient although the shadow can be found by a method to be explained in the next problem.

76. As in any problem in shades and shadows, the first step is to determine the shade line.

The scotia is bounded above and below by fillets which are portions of right cylinders. The shadow on the scotia is formed by the shadow of the upper fillet or right cylinder upon the surface of the scotia. We determine the shade lines of the cylinder, Problem XI, by applying to the plan the projections of the ray, Fig. 31. These determine the shade elements at x^h and y^h and also the portion of the perimeter of the fillet, $x^h a^h y^h$, which is to cast the shadow on the scotia.

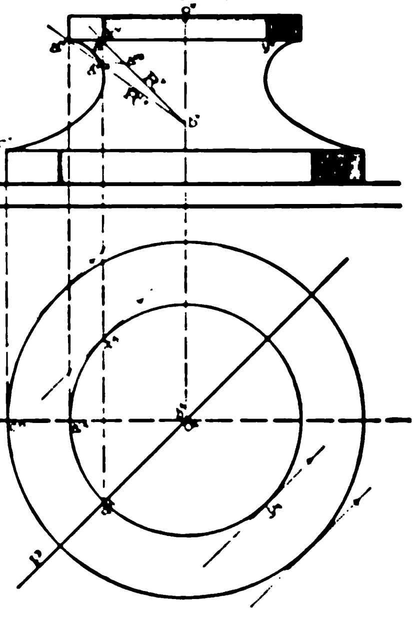
In this case, as in most scotias, the shadow of the shade elements of the cylinder falls not on the scotia itself, but beyond on the H or V plane, or some other object, hence we can neglect them for the present.

Having determined the shade line, there is another preliminary step to be taken before finding its shadow. That is, to determine the highest point in the shadow a^{vs}. We do this to know where it is useless to pass auxiliary planes through the scotia. Such planes would evidently be useless between the point a^{vs} and the shade line $x^{v}a^{v}y^{v}$ in elevation. Also because we could not be sure that in passing the auxiliary planes we were passing a plane which would determine this highest point.

The highest point of shadow a^{vs} is determined, therefore, as follows:

The point a^{h}, lying on the diagonal Po^{h} is evidently the point in the shade line which will cast the highest point in the shadow, for, considering points in the shade line on either side of a^{h}, it will become evident that the rays through them must intersect the scotia surface at points lower down than the point a^{vs}.

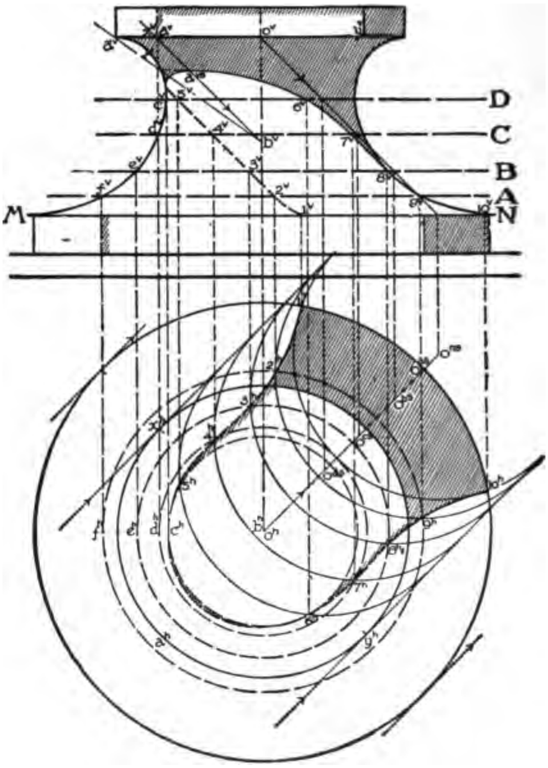
FIG·31



The point a lies in a plane of light P, which passes through the axis ob of the scotia. This plane, therefore, cuts out of the scotia surface a line of intersection exactly like the profile $a^{v}c^{v}$. If we revolve the plane P and its line of intersection about the axis ob until it is parallel to V, the line of intersection will then coincide with this profile $a^{v}c^{v}$, the point a^{v} having moved to the point a'^{v}.

If, before revolving, we had drawn the projections of the ray of light, R^{v}, through the point a^{v}, they would be the lines $a^{v}b^{v}$ and $a^{h}b^{h}$. After the revolution of the plane P these projections of the ray are the lines $a'^{v}b^{v}$ and $a'^{h}b^{h}$. The point b, being in the axis, does not move in the revolution of the plane P. The point a'^{vs}, the intersection of the projection of the ray R'^{v} with the profile $a^v c^c$, indicates that the ray R'^v has pierced the scotia surface. If now the plane P is revolved back to its original position, this point a'^{vs} will move in a horizontal line in elevation to the point a^{vs}, and the point a^{vs} thus obtained is the shadow of the point a^v on the surface of the scotia and is also the highest point of the shadow.

FIG-32



77. The remainder of the process is, from now on, similar to the method just explained in the previous problem. See Fig. 32.

We pass auxiliary planes, A, B, C, etc., (in this case parallel to H) through the scotia.

We determine in plan their respective lines of intersection with the scotia: they will be circles.

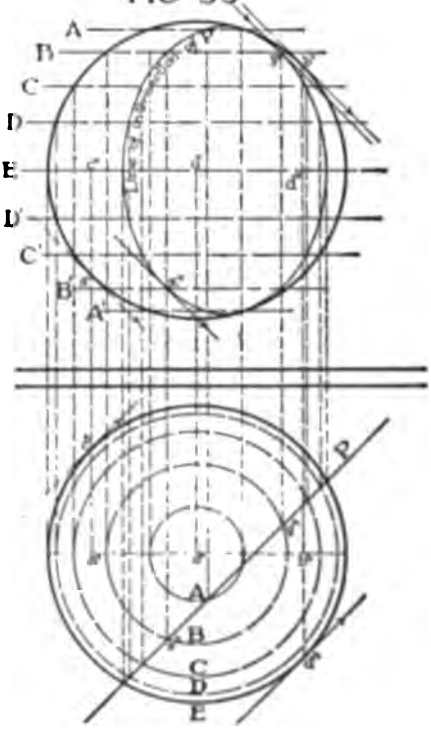
Cast the shadow of the arc $x^h a^h y^h$ on each of these auxiliary planes. This is done by casting the shadow of its center O and drawing arcs equal to $x^h a^h y^h$.

The points of intersection, 2^h, 3^h, 4^h, 5^h, 6^h, etc., are points in the required shadow in plan. The points 1^h and 10^h are the ends, where the shadow leaves the scotia and these are determined by taking one of the auxiliary planes at the line MN. The points 1^v, 2^v, 3^v, etc., are obtained in the elevation by projection from the plan.

The shade of the lower fillet is determined by Problem XI.

78. In case the fillets are conical instead of cylindrical surfaces, as is sometimes the case in the bases of columns where the scotia moulding is most commonly found, care must be taken to first determine the shade elements of the conical surface. This supposition of conical surfaces would mean a larger arc for the shade line than the arc $x^h t^h y^h$.

FIG·33



USE OF PLANES OF LIGHT PERPENDICULAR TO THE CO-ORDINATE PLANES.

79. Another method often necessary and convenient in casting the shadows of double-curved surfaces is the use of *planes of light perpendicular to the co-ordinate planes.*

These auxiliary planes of light are passed through the given object. They will cut out lines of intersection with the object and to these lines of intersection can be applied the projections of the rays of light which lie in the auxiliary planes of light. The points of contact or tangency, as the case may be, of the projections of the rays and the line of intersection are points in the required shadow.

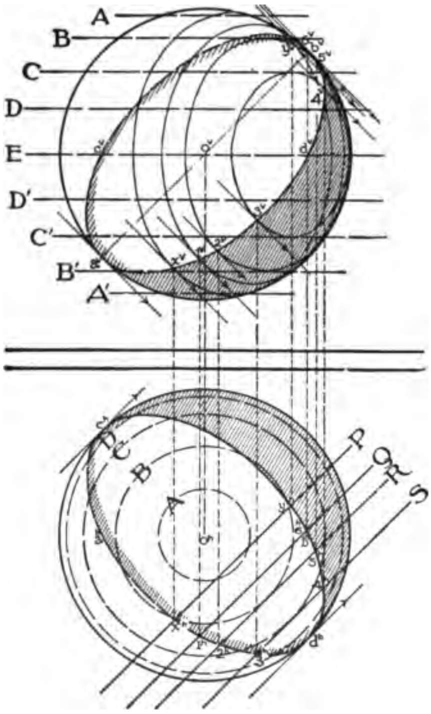
80. The use of this method will be illustrated by finding the shadow of a sphere in the following problem. The shadow of the sphere serves to illustrate this method well, but another

and more convenient method is given later in Problem XXIX for determining the shade line of the sphere and its shadow.

81. Problem XV. To find the shade line of a sphere.

In Fig. 33 is shown the plan and elevation of a sphere. Through the sphere in plan, pass the auxiliary *plane of light* P, perpendicular to H. This cuts out of the sphere the "line of intersection," shown in the elevation. This "line of intersection" is determined by using the auxiliary planes A, B, C, D, etc., each plane giving two points in the line. To this line of intersection made by the *plane of light* P, with the sphere, we apply the projections of the ray and obtain two points, $x^v y^v$, in the required shade line. Other points can be determined by using a number of these planes of light, as shown in Fig. 34, P, Q, R and S.

FIG·34



The points x^v and y^v can be projected to the plan to determine the shade line there. The ends of the major axis of the ellipse a^v and b^v are determined by applying directly to the sphere the projections of the ray. The same is true of the plan.

82. *Problem XVI. To find the shadow of pediment mouldings.

Fig. 35 shows a series of pediment mouldings in elevation, the mouldings being supposed to extend to the left and right indefinitely. At the left is a "Right Section," showing the profile of each moulding forming the pediment.

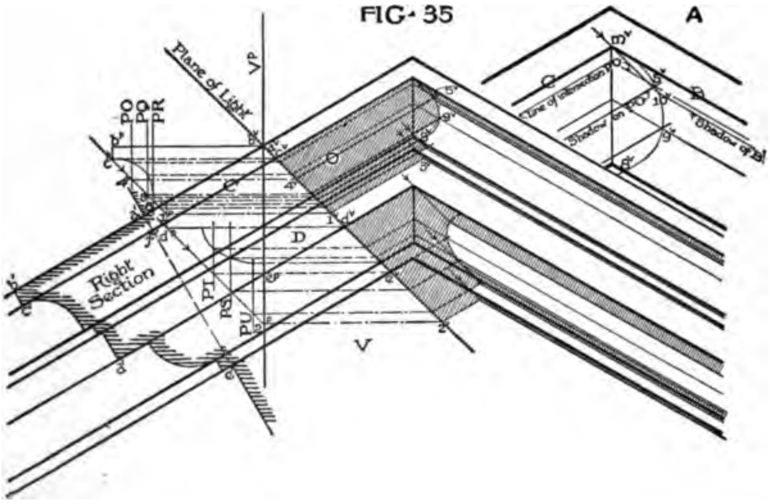
The shadow of such an object can be most conveniently found by the use of a plane of light perpendicular to the V plane and intersecting the mouldings.

***Optional.**

If such a "Plane of Light" (45° line) as that shown in Fig. 35 is passed through the mouldings, it will be evident that this plane will cut the mouldings along a line of intersection which can be made use of in determining the shadow of each moulding upon the others. If we find the profile projection of this line of intersection using the right section, we can apply the profile projections of rays of light to the line of intersection. It will then be evident what faces the light strikes directly and to what edges the rays are tangent.

The line of intersection in Fig. 35 made by the Plane of Light

FIG. 35



is shown in vertical projection by the 45° line $a^v b^v c^v d^v$, etc. The profile $a^p b^p c^p d^p$, etc., is the profile projection of this line of intersection; the point b^p is evidently on a horizontal line to the left of the point a^v at a distance from the line V^p (*profile projection of V*) equal to $a'b'$, obtained from the *Right Section*. In the same way the point c^p is on a horizontal line to the left of c^v and at a distance from the line V^p equal to the distance $c'f'$ also obtained from the *Right Section*. In a similar manner the other points in the profile projection are found. The vertical line $b^p c^p$ is the profile projection of the line of intersection which the Plane of Light makes with the fillet, this line in direct elevation is $b^v c^v$.

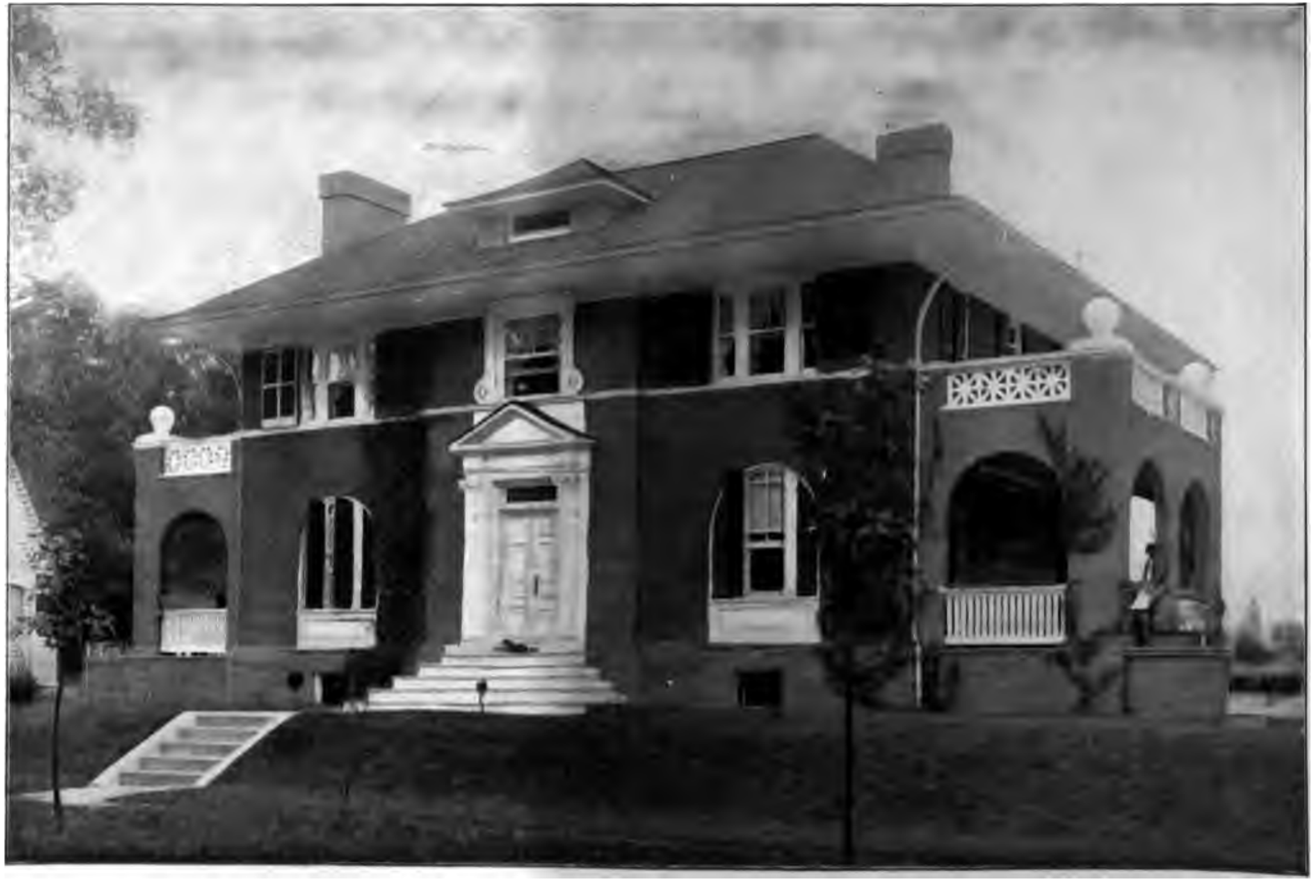
If we now apply to this profile projection of the line of intersection the profile projections of the ray (45° lines) we see that the fillet $b^p c^p$ is in the light, and that the ray is tangent to its lower edge c^p. We also see that this tangent ray strikes the face D at the point l^p; this means that the shadow of the edge c falls upon the face D. Since the mouldings of the pediment are all parallel to each other, the edge c is parallel to the face D, therefore, (30) the shadow of c on D will be parallel to C itself. This shadow is found in the elevation by drawing a horizontal line from the point l^p back to the *Plane of Light*. This operation gives the point 1^v and we draw through the point 1^v a line parallel to the edge C, as a part of the required shadow. Evidently that portion of the elevation between the edge C and its shadow will be in shadow.

In a like manner the edge d^p is found to cast its shadow on the plane V, below the pediment mouldings proper, and its shadow is of course a line drawn through 2^v parallel to the lines of the mouldings.

To return to the shadow of the edge C on the face D. It will be noticed that, if this is extended far enough, it will cross the pediment mouldings on the right-hand slope; as these are not parallel to the edge C, the shadow on them will not be a parallel line and we must use a separate, though similar, method for determining this portion of the shadow.

If auxiliary planes O, Q and R parallel to V are passed through the crowning moulding, they will cut out of it lines of intersection which will be parallel to the other lines of the pediment. (See the enlarged diagram at A showing the line of intersection of the auxiliary plane O.)

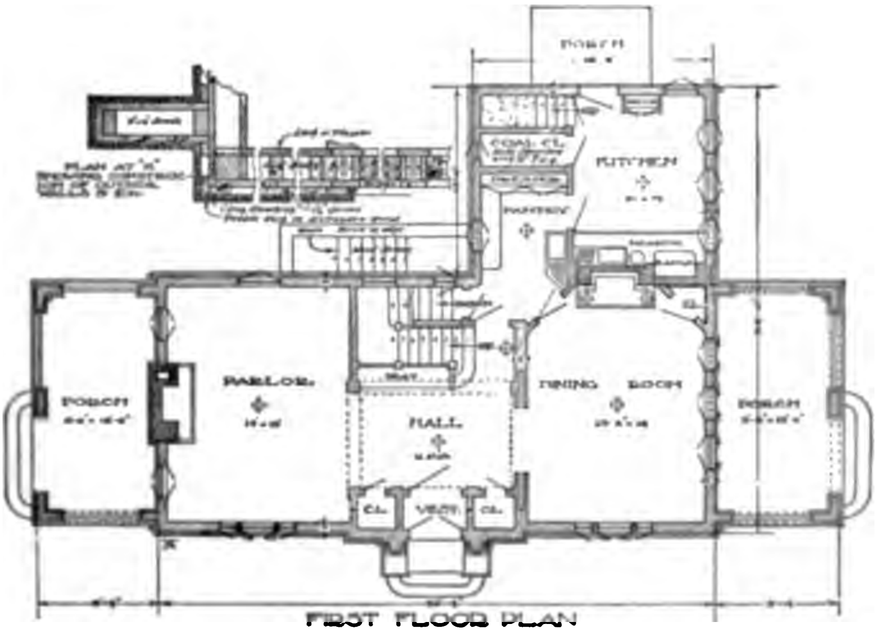
If we cast the shadow of the edge C on this plane O, by drawing the 45° line from c^p to the line PO (the profile projection of O) and from the point 4^p draw a horizontal line back to the *Plane of Light*, we shall obtain the line O (see "shadow on PO" in diagram A). This shadow will cross the *Line of intersection of PO* at the point 5^v. The point 5^v will be one point in the shadow of the edge C (indefinitely extended) on the right-hand slope of the pediment. Other points, 8^v and 9^v, can be found in a like manner by use of the auxiliary planes Q and R. Through a sufficient number of these points the curve $5^v 9^v 8^v$ is drawn. This curve is the required shadow. The shadow of the end of the edge C is found by drawing a 45° line from the point m^v (diagram A) to the



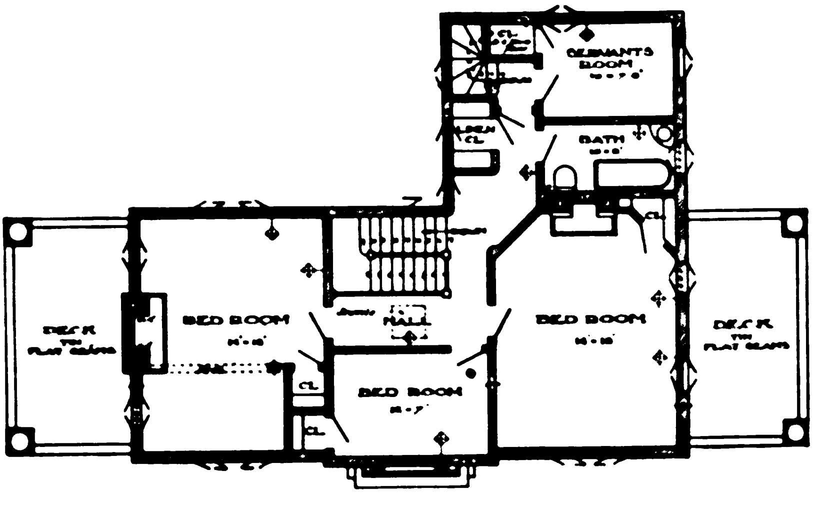
RESIDENCE OF MRS. BACHRACH, WASHINGTON, D. C.

Wood, Donn & Deming, Architects, Washington, D. C.

Walls of Stucco on Wire Lath. A Three-Quarter Engaged Ionic Column Used on Entrance Feature. For Plans, See Opposite Page.



FIRST FLOOR PLAN

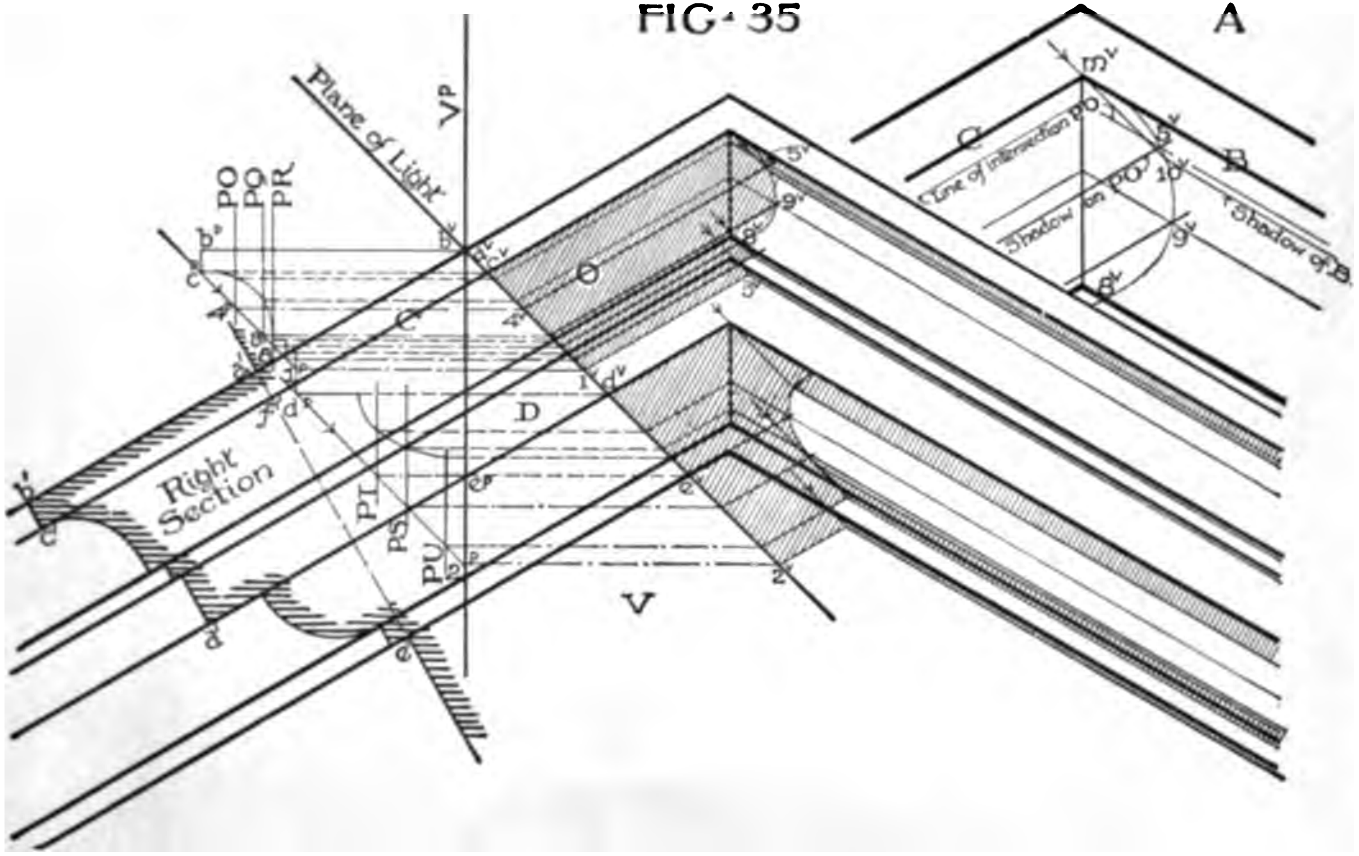


SECOND FLOOR PLAN

PLANS OF RESIDENCE OF MRS. BACHRACH, WASHINGTON, D. C.

Wood, Donn & Deming, Architects, Washington, D. C.

FIG. 35

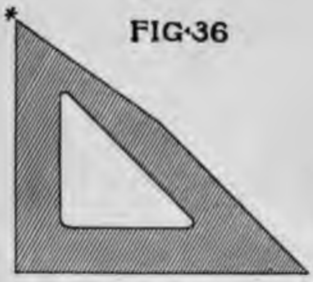

A
B
C
Line of intersection PO
Shadow on PO
Shadow of B
Plane of Light
VP
PO
PQ
PR
O
C
D
Right Section
PT
PS
PU
V
b
c
d
e

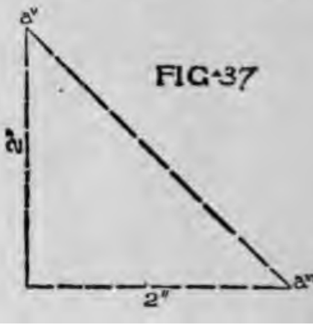
curve. The point of intersection, 10^v, is the shadow of the end of the edge C. It is also the beginning of the shadow of the edge B on the right-hand slope, which shadow is parallel to B.

The remaining shadows of the pediment are found in the same manner, and may be understood, from the diagram, without a detailed explanation.

SHORT METHODS OF CONSTRUCTION.

83. The following problems illustrate short and convenient methods of construction for determining the shadows of lines, surfaces and solids, in the positions in which they commonly occur in architectural drawings. These methods here worked out with regard to the co-ordinate planes apply also to parallel planes.


FIG·36


FIG·37

84. They will be found to be of great assistance in casting the shadows in architectural drawings. The latter seldom have the plan and elevation on the same sheet, and these methods have been devised to enable the shadows to be cast on the elevation without using construction lines on the plan or profile projection. Such distances as are needed and obtained from the plan, can be taken by the dividers and applied to the construction in the elevation.

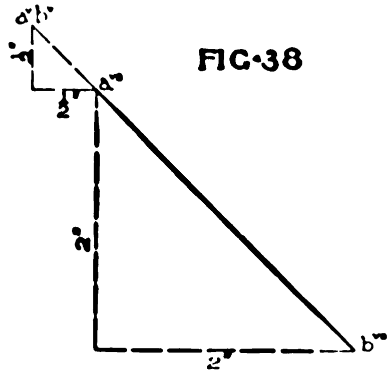
In casting shadows it will be found convenient to have a triangle, one of whose angles is equal to the true angle which the ray of light makes with the co-ordinate plane. See Fig. 36. With such a triangle the revolved position of the ray of light can be drawn immediately without going through the operation of revolving the ray parallel to one of the co-ordinate planes.

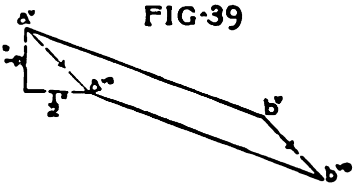
85. **Problem XVII. To construct the shadow on a co-ordinate plane of a point.**

It will lie on the 45° line passing through the point and representing the projection of the ray of light on that plane. It will be situated on the 45° line at a distance from the given point, equal to the diagonal of a square, the side of which is equal to the distance of the point from the plane.

Given the vertical projection of the point a situated 2 inches from the V plane, to construct its shadow on V. Fig. 37.

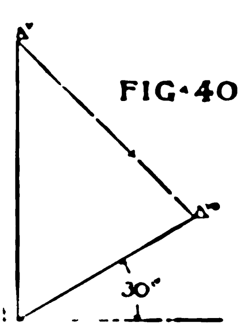
From the point a^v draw the 45° degree line a^va^{vs} equal in length to the diagonal of a square whose sides measure 2 inches. Then a^{vs} is the required shadow.

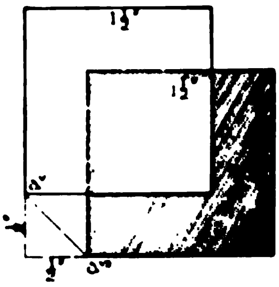

FIG·38


FIG·39

86. **Problem XVIII. To construct the shadow of a line perpendicular to one of the co-ordinate planes.**

(1) It will coincide in direction with the projection of the ray of light upon that plane, without regard to the nature of the surface upon which it falls.


FIG·40


FIG·41

(2) The length of its projection upon that plane will be equal to the diagonal of a square, of which the given line is one side.

Given the vertical projection of the line ab perpendicular to

V, 2 inches long and $\frac{1}{2}$ inch from V, to construct its shadow on V. See Fig. 38. Find the shado of the point a^v by Problem XVII.

From the point a^{vs} draw the 45° line $a^{vs}b^{vs}$ equal to the diagonal of a square 2 inches on each side.

86. **Problem XIX. To construct the shadow of a line on a plane to which it is parallel.**

(1) It will be parallel to the projection of the given line.

(2) It will be equal in length to the projection of the line.

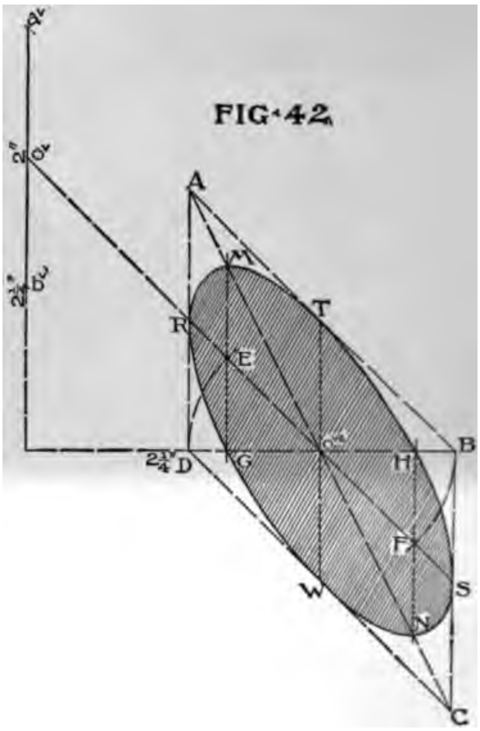
Given the vertical projection of the line ab, parallel to V, 2 inches in length and $\frac{1}{2}$ inch from V, to construct its shadow on V. See Fig. 39.

Find the shadow of a^v by Problem XVII.

Draw $a^{vs}b^{vs}$ parallel and equal in length a^vb^v.

87. **Problem XX. To construct the shadow of a vertical line on an inclined plane parallel to the ground line.**

It makes an angle with the horizontal equal to the angle which the given plane makes with H.


FIG·42

Given the vertical projection of a vertical line ab, its lower end resting on a plane parallel to the ground line and making an angle of 30° with H, to construct its shadow on this inclined plane. See Fig. 40. Through the point b^v draw the 30° line b^va^{vs}. The point a^{vs}, the end of the shadow, is determined by the intersection of the 45° line drawn through the end of the line a^v.

88. **Problem XXI. To construct the shadow on a co-ordinate plane of a plane which is parallel to it.**

(1) It will be of the same form as that of the given surface.

(2) It will be of the same area.

If the plane surface is a circle, the shadow can be found by finding the shadow of its center, by Problem XVII, and with that as a center describing a circle of the same radius as the given circle.

Given a plane parallel to V, ½ inch from V and 1½ inches square, to construct its shadow on V. See Fig. 41.

Find the shadow of any point a^v for example, by Problem XVII. On that point of the shadow construct a similar square whose side equals 1½ inches.

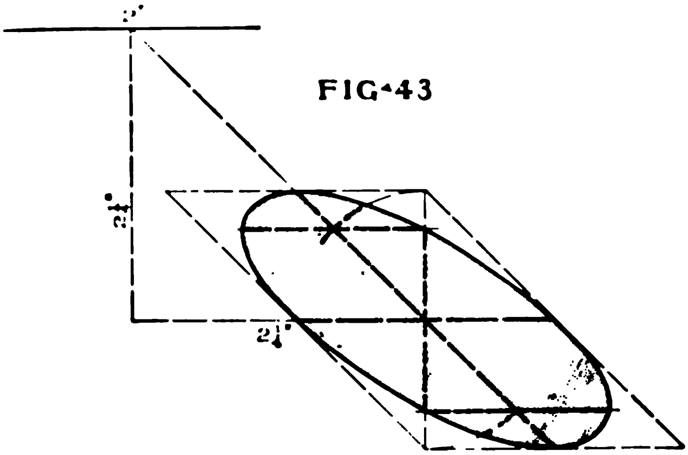


FIG. 43

89. **Problem XXII. To construct the shadow on V of a circular plane which is parallel to H, or which lies in a profile plane.**

Given $a^vo^vb^v$, the projection of a circular plane perpendicular to V and H, 2 inches in diameter, its center being 2¼ inches from V, to construct shadow on V. Figs. 42 and 43. The shadow of o^v, the center of the circular plane is found by Problem XVII. About o^s as a center, construct the parallelogram ABCD made up of the two right triangles ADB and DBC, the sides adjacent to the right angles being equal in length to the diameter, 2 inches, of the circular plane. Draw the diameters and diagonals of this parallelogram. The diameter TW is equal to the diameter of the given circle and parallel to it.

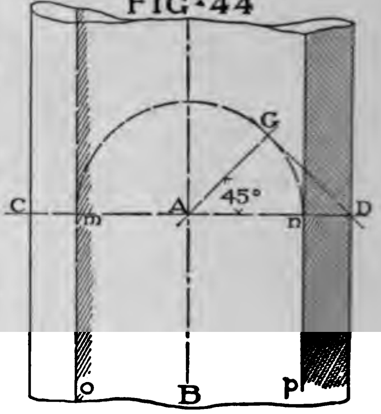
With o^s as a center and OD and OB as radii, describe the arcs cutting the major diameter of the parallelogram in the points

E and F. Through E and F draw lines parallel to the short diameter, cutting the diagonals in the points G, H, M and N. These last four points and the extremities of the diameters R, S, T, and W, are eight points in the ellipse which is the shadow of the given circular plane on V. A similar construction is followed for finding the shadow on V of a circular plane parallel to H. Fig. 43.

90. **Problem XXIII. To construct the shade line of a cylinder whose axis is perpendicular or parallel to the ground line.**

Given the elevation of a cylinder, its axis being AB perpendicular to H. To construct shade lines. Fig. 44.

FIG·44



Let CD be any horizontal line drawn through the cylinder.

Construct the 45° isosceles triangle AGD on the right half of the diameter.

With the radius AG describe the semi-circular arc *m*G*n*, cutting the horizontal line CD in the points *m* and *n*.

These two points will determine the shade elements *mo* and *np*.

91. **Problem XXIV. To construct the shadow on a plane (parallel to its axis) of a circular cylinder whose axis is either perpendicular, or parallel to the ground line.**

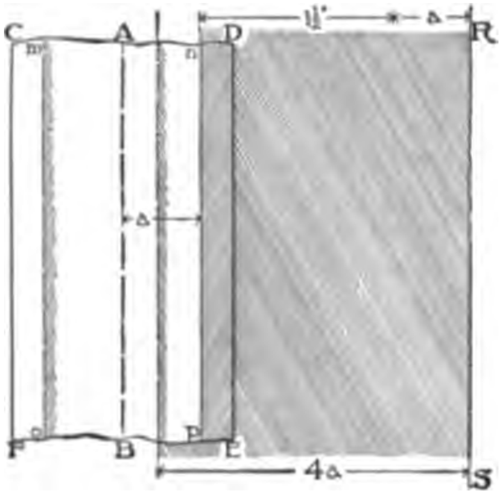
Let a=the distance, in the elevation, between the projection of the axis of the cylinder and the projection of the visible shade element. Let b=the distance between the axis of the cylinder and the plane on which the shadow falls, to be obtained from the plan.

Then the distance, between the visible shade element and its shadow on the given plane, will be equal to $a+b$.

The width of the shadow on the given plane will be equal to $4a$.

Given the circular cylinder CDEF (Fig. 45), its axis AB perpendicular to H. To construct its shadow on the V plane which is 1½ inches distant from the axis AB. The shade elements *mo* and *np* can be constructed by Problem XXIII. Draw RS the shadow of the shade element *np*, parallel to *np*, and distant from it *a* + 1½ inches. The width of the shadow on the given plane will be 4 times the distance A*n*.

FIG·45



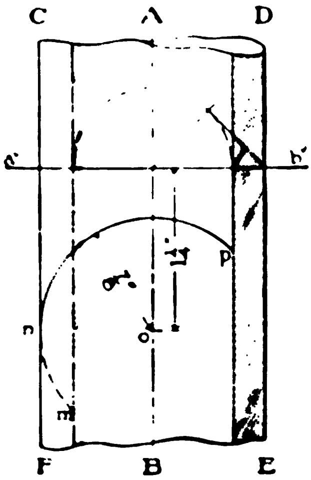
92. **Problem XXV. To construct the shadow on a right cylinder of a horizontal line.**

a. It will be the arc of a circle of the same radius as that of the cylinder.

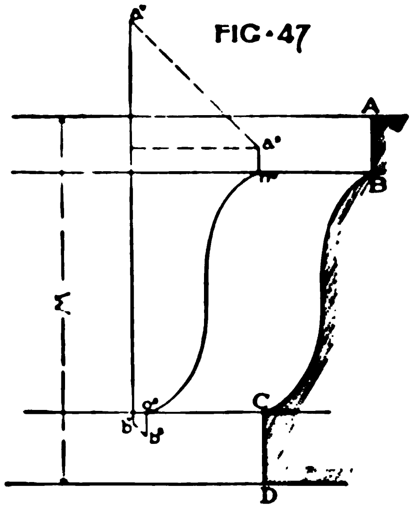
b. The center of the circle will be on the axis of the cylinder as far below the given line as that line is in front of the axis.

Given a right circular cylinder CDEF, whose diameter is 1¾ inches, and a horizontal line *ab*, 1¼ inches in front of the axis of the cylinder. To construct the shadow. Fig. 46.

FIG·46



FIG·47



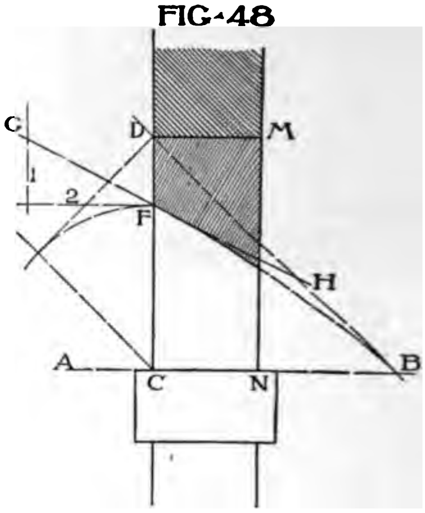
Locate the point *o* on the axis 1¼ inches below *a'b'*. With *o* as a center, and radius equal to $\frac{7}{8}$ inch describe the **arc** *mnp*, **the** required shadow.

93. **Problem XXVI. To construct the shadow of a vertical line on a series of mouldings which are parallel to the ground line.**

The shadow reproduces the actual profile of the mouldings.

Given a vertical line $a^v b^v$ which casts a shadow on the moulding M, which is parallel to the ground line, and whose profile is shown in the section ABCD. The line $a^v b^v$, is 1 inch in front of the fillet AB. To construct its shadow, Fig. 47:

FIG-48



Construct the shadow on the fillet AB, of the end of the line a^v, or any other convenient point in the line, by Problem XVII. From the point a^s the shadow of the line reproduces the profile ABCD and we obtain $a^s n^s o^s b^s$, the required shadow.

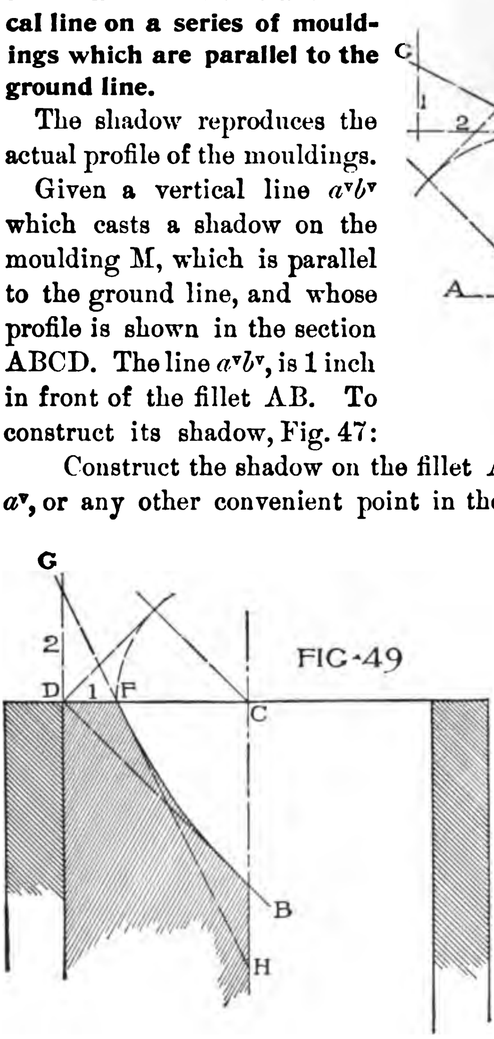


FIG-49

94. **Problem XXVII. To construct the shadow on the intrados of a circular arch in section, the plane of the arch being in profile projection.**

Let AB (Fig. 48) be the "springing line" of the arch. Let CD be the radius of the curve.

The point F is determined by the construction used in finding the shade element of a cylinder. Problem XXIII. At the point F draw the line GH, with an inclination to the "horizontal" of 1 in 2. Through the point D draw the 45° line DB. The curve of the line of shadow will be tangent to these two lines at the points F and B. The required shadow is that portion of the curve between the lines DC and MN.

A similar construction is used in the case of a hollow semi-cylinder when its axis is vertical, except, that the line GH has then an inclination to "the horizontal" of 2 in 1. Fig. 49.

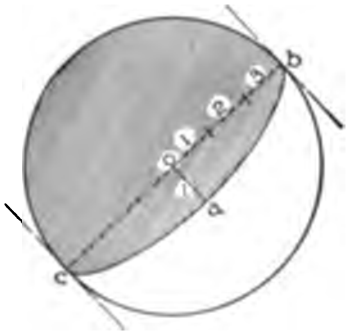
95. **Problem XXVIII. To construct the shadow of a spherical hollow with the plane of its face parallel to either of the co-ordinate planes.**

The line of shadow is a semi-ellipse. The projections of the rays of light tangent to the circle determine the major axis. The semi minor axis is equal to $\frac{1}{3}$ the radius of the circle.

Given the vertical projection of a spherical hollow, the plane of its face parallel to V. Fig. 50.

Determine the ends of the major axis by drawing the projections of the rays of light tangent to the hollow. The semi-minor axis, *oa*, equals $\frac{1}{3}$ the radius *ob*. On *bc* and *oa* construct the semi-ellipse, the required shadow.

FIG·50



96. **Problem XXIX. To construct the shade line and shadow of a sphere. Fig. 51.**

Let the circle whose center is *o* be the vertical projection of a sphere whose center is at a distance *x* from the V plane.

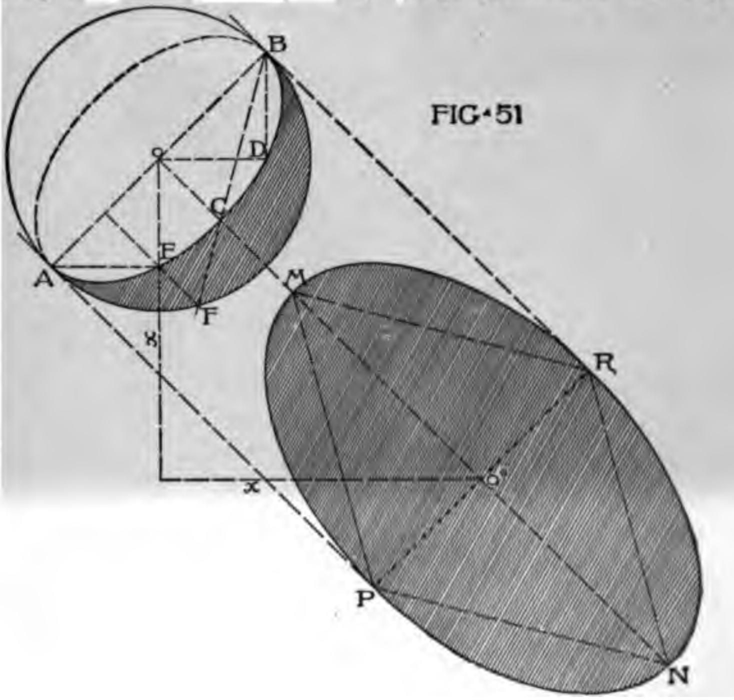
The shade line will be an ellipse. The major axis of this ellipse is determined by the projections of the rays of light tangent to the circle. The semi minor axis and two other points can be determined as follows:

Through the points, A, *o*, and B, draw vertical and horizontal lines, intersecting in the points E and D.

The points E and D are two points in the required shade line.

Through the point E draw the 45 line EF. Through the point F, where this line intersects the circle, and the point B, draw the line FB. The point C, where this line FB intersects the 45 line through the center of the sphere, *o*, is the end of the semi-

[illegible] on the co-ordinate plane will [illegible] of [illegible] is ellipse, o^s, will be the shadow of [illegible] t [illegible] It [illegible] ll be determined by Problem VII. T [illegible] the [illegible] N, will be on the projection of the ray of [illegible] t d [illegible] ter of the sphere. The minor axis PR will [illegible] a l [illegible] rig [illegible] to this through the point o^s. Its length [illegible] l be [illegible] by [illegible] he projections of the rays of



FIG·51

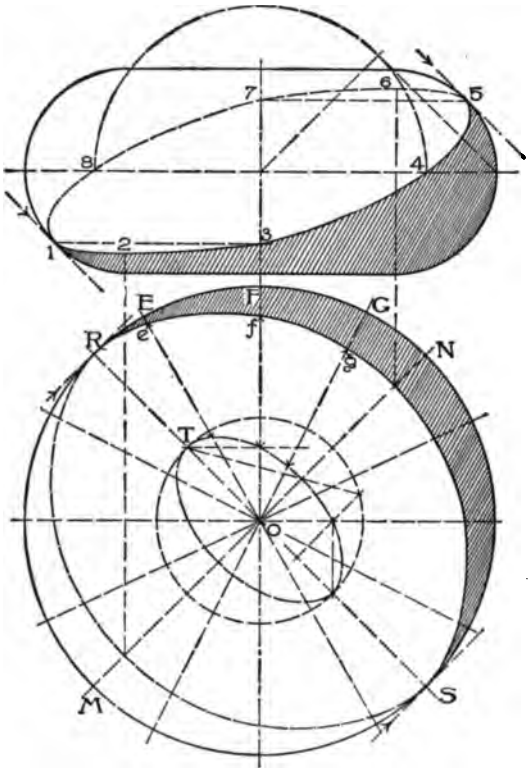
light BR and AP tangent to the circle, and is equal to the diameter of the sphere. The points M and N, which determine the ends of the major axis, are the apexes of equilateral triangles PMR and PNR, constructed on the minor axis as a base.

97. Problem XXX. To construct the shade line of a torus.

Fig. 52, in elevation: The points 1 and 5 can be determined by drawing the projections of the rays of light tangent to the elevation. Since the shade line is symmetrical on either side of the line MN in plan, the points 3 and 7 can be found from 1 and 5, by drawing horizontal lines to the axis. The points 4 and 8 are determined by the construction used in finding the shade elements of a cylinder. Problem XXIII.

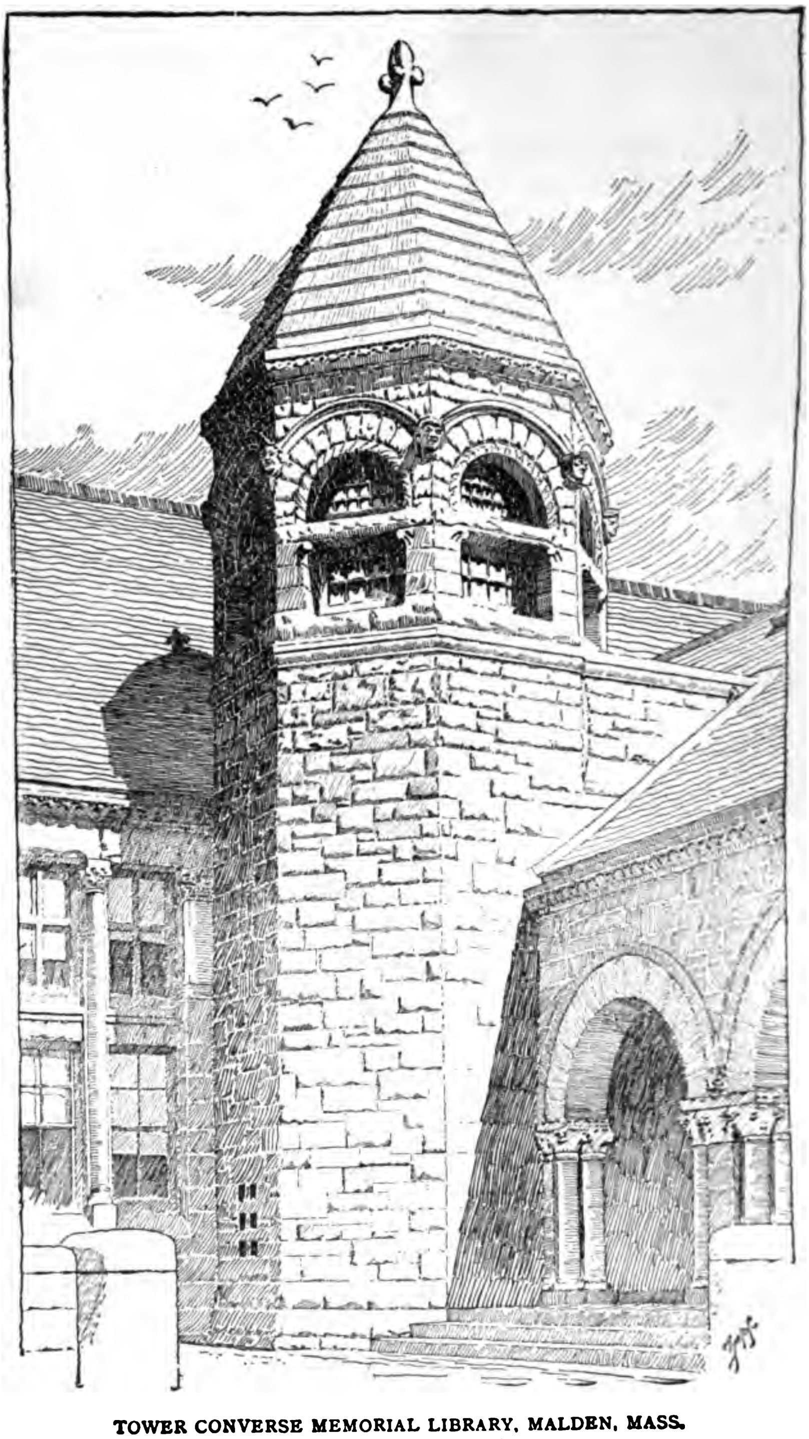
The above points can be determined without the use of plan.

FIG. 52



The highest and lowest points in the shade line, 2 and 6, can be found only by use of plan. It is not necessary, as a rule, to determine accurately points 2 and 6. The shade line in plan will be, approximately, an ellipse whose center is *o*. The ends of the major axis R and S, are determined by the projections of the rays of light tangent to the circle. Other points can be determined without the use of the elevation as follows: With center *o*, construct the plan of a sphere whose diameter equals that of the circle which generated the torus. Determine the shade line by Problem XXIX. Draw any number of radii OE, OF, OG, etc.

On these radii, from the points where they intersect the shade line of the sphere, lay off the distance RT, giving the points *c*, *f* and *g*. These are points on the required shade line.



TOWER CONVERSE MEMORIAL LIBRARY, MALDEN, MASS.
H. H. Richardson, Architect.
Note treatment of shadows in a perspective drawing.

SHADES AND SHADOWS.

EXAMINATION PLATES.

98. **General Directions.** Plates are to be drawn in pencil. Show distinctly and leave all construction lines.

Shadows are to be cross-hatched lightly, and their outline drawn with a distinct black line.

PLATE I.

99. See directions on plate.

PLATE II.

100. Find the shadows of lines *ab*, etc., in Problems XIV-XVI.

101. In Problem XVII find the shadow of line *ab* on the planes A, B, and C.

102. In Problem XVIII find the shadow of plane *abcd*.

PLATE III.

103. See directions on plate.

PLATE IV.

104. See directions on plate.

PLATE V.

105. In Problem XXV find all the shadows on the steps and the shadows on the co-ordinate planes in plan and elevation. Letter carefully the various planes in elevation and plan.

106. In Problem XXVI find all the shades and shadows of the cylinder and its shadows on the co-ordinate planes.

PLATE VI.

107. In Problems XXVIII and XXIX find the shades and shadows of objects and their shadows on the co-ordinate planes.

108. In Problem XXX, C is a square projection or fillet on the V plane. Below this fillet and also applied to the V plane are portions of two cylinders, DD, which support the fillet C Find the shades and shadows in elevation only.

A II.

1 P XXXI, a spherical hollow, its plane

110. Pro XXXII, a scotia moulding, the upper fillet fr m or one, the lower fillet is a cylinder. its eva nd plan.

* A VIII.

112. Problem XXXIII s a series of pediment mouldings applied to a vertical wall A. Find the shadows on the mouldings and the shadows of the mouldings on the vertical plane A.

PLATE IX.

113. In Problem XXXIV find the shadows of a given window.

114. In Problem XXXV find the shadows of the given keyblock and the shadow of the keyblock on the vertical wall to which it is applied. Use the short methods of construction and use the plan only from which to take distances.

PLATE X.

115. Problem XXXVI. Given the upper portion of a Doric order, the column being engaged to the vertical wall V, see plan. The entablature breaks out over the column, see plan. Find all the shadows, using the short methods of construction and use the plan only to obtain required distances.

PLATE XI.

116. Problem XXXVII. Given a rectangular niche, as shown by the plan, having a circular head as shown by the elevation. Situated in the niche is a pedestal in the form of truncated square pyramid. This pedestal has on its four side faces projections as shown in the elevation and plan. On the pedestal rests a sphere. Find all the visible shadows in the elevation. Use the short methods of construction and use the plan only for determining distances.

117. Problem XXXVIII. Given a niche in the form of a spherical hollow. The profile of the architrave mouldings is shown at A. Find all the shadows. Use the short methods of construction.

PLATE XII.

118. Problem XXXIX. Given the lower part of a column standing free from a vertical wall, and resting on a large square base, the base having a moulded panel in its front face. At the foot of the vertical wall is a series of base mouldings, the lower ones cutting into the side of the square base on which the column stands, see plan. Find all the visible shadows, using the short methods of construction.

---

*Optional.

SHADES & SHADOWS PLATE 1

1 Define shade

2 Define shadow.

3 Define umbra.

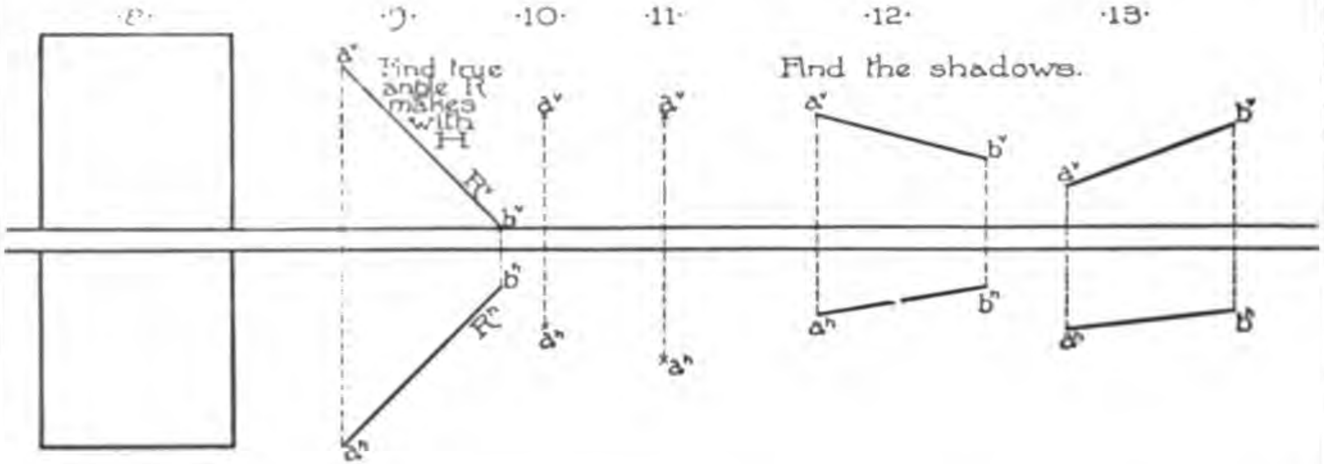
4 What is a shade line?

5 What is a plane of light?

6 What is true of the shadow of a line on a plane to which it is parallel?

7 What is true of the shadow of a line on a plane to which it is perpendicular?

8 Draw the diagonals of cube which represent the projections of the ray of light.



Find true angle R makes with H

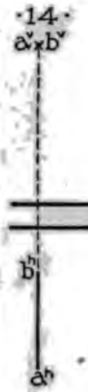
Find the shadows.

DATE NAME

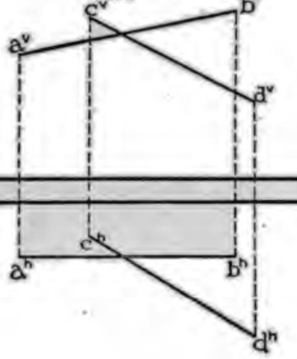
SHADES & SHADOWS

PLATE II

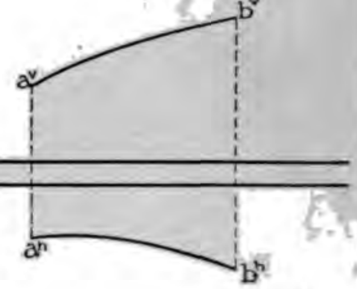
·14·



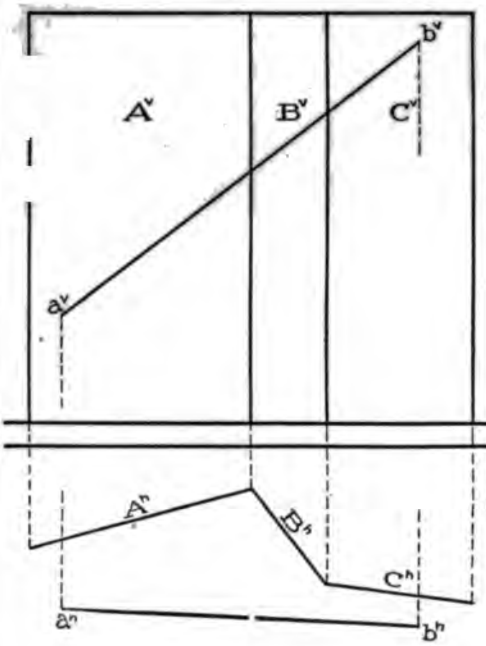
·15·



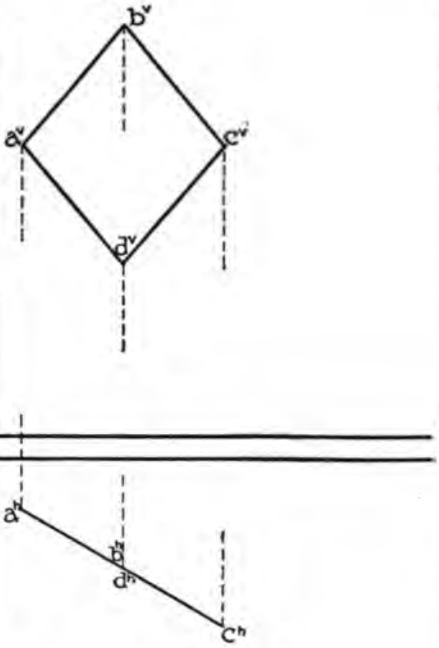
·16·



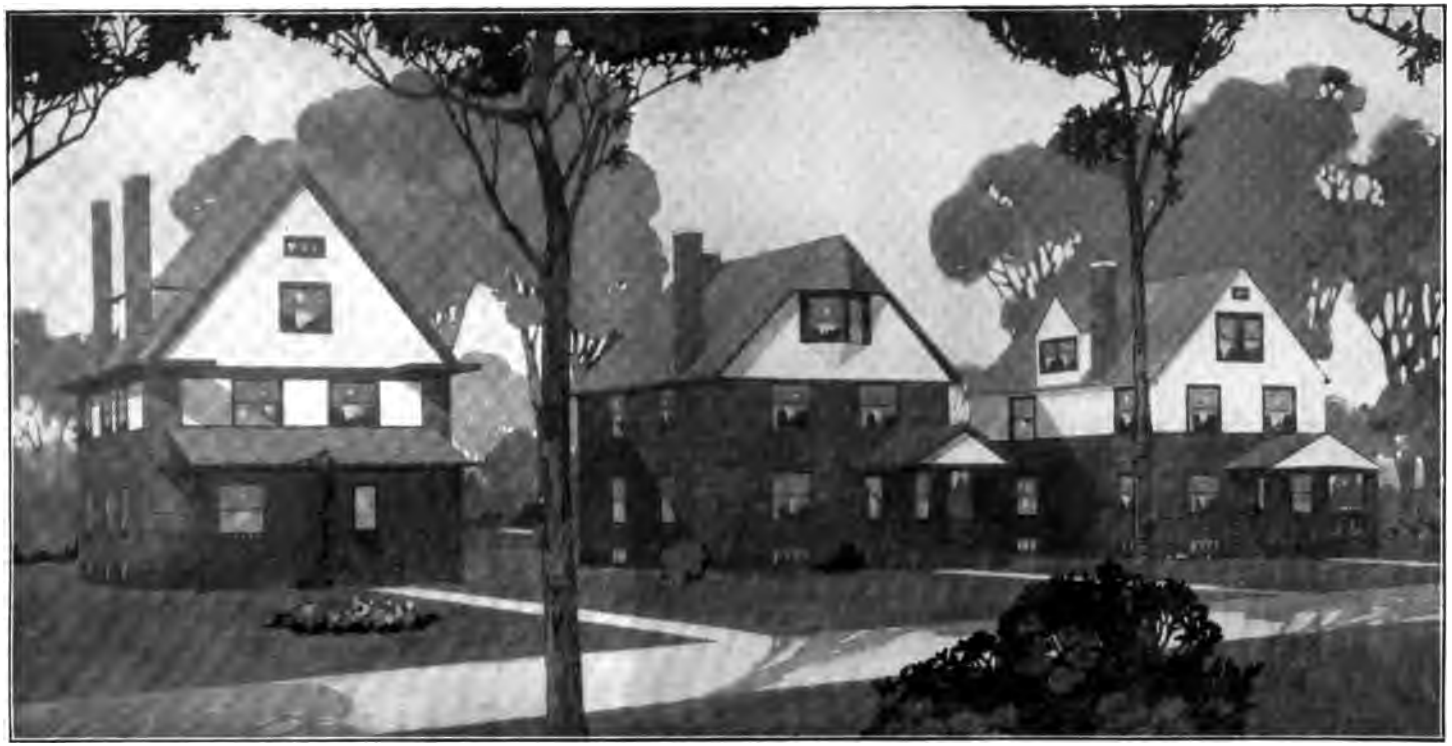
·17·



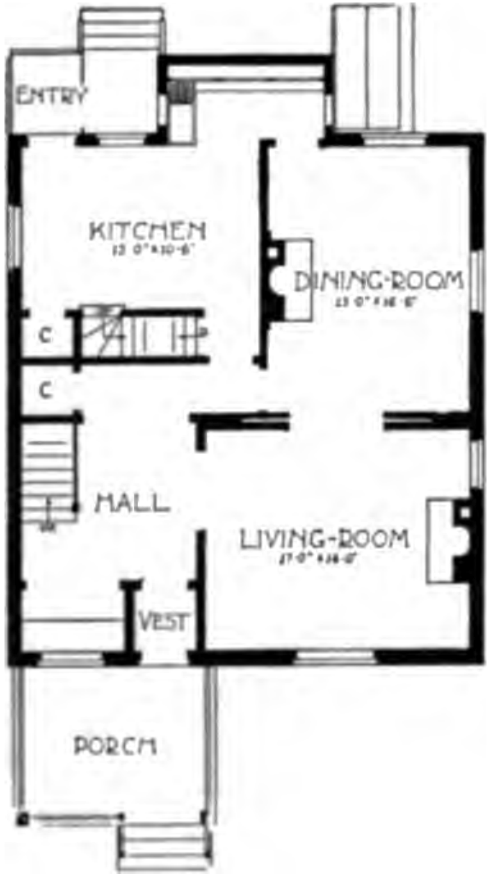
·18·



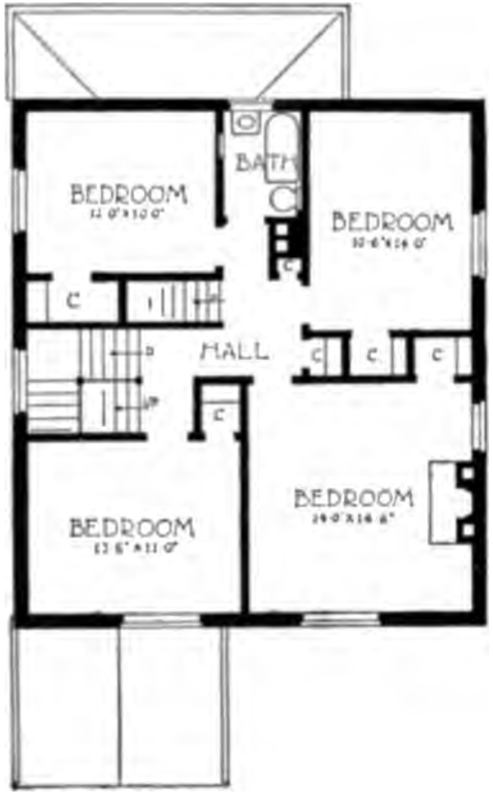
DATE NAME



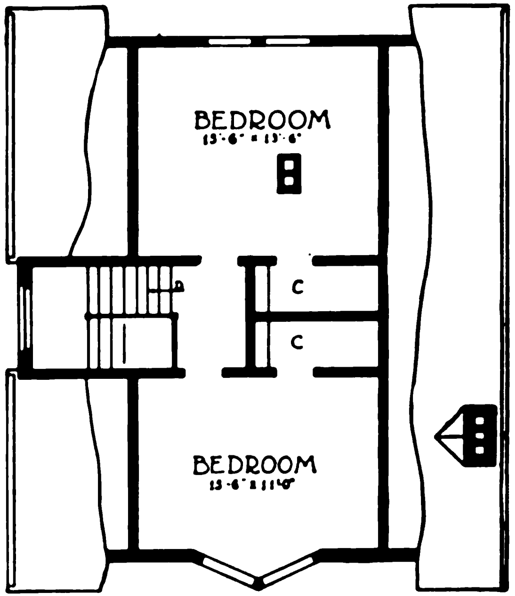
THREE HOUSES FOR INDIANA STEEL COMPANY, GARY, IND.
Dean & Dean, Architects, Chicago, Ill.
Paving Brick Veneer and Plaster; Tile Roofs.



First-Story Plan.



Second-Story Plan.

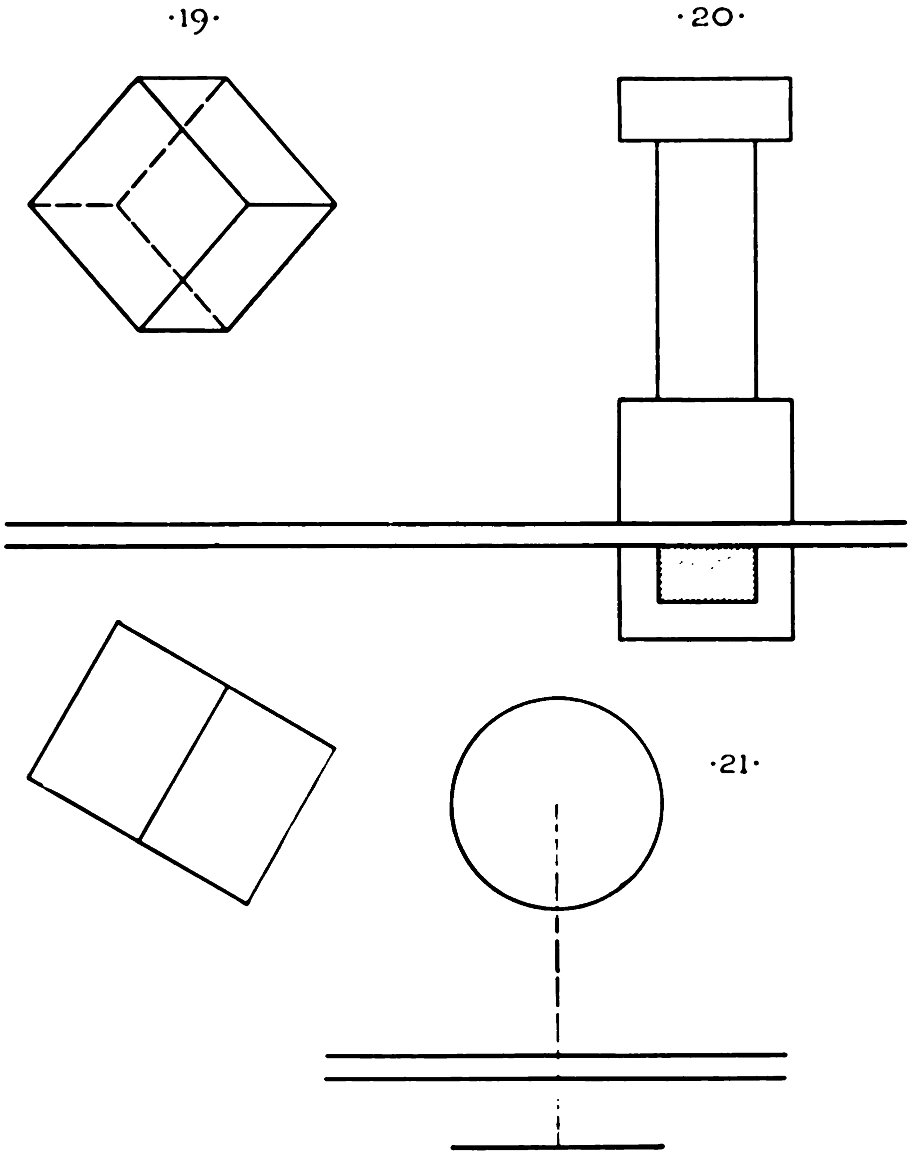


Third-Story Plan.

THREE HOUSES FOR INDIANA STEEL COMPANY, GARY, IND.
Dean & Dean, Architects, Chicago, Ill.
Exteriors Shown on Opposite Page.

SHADES & SHADOWS PLATE III

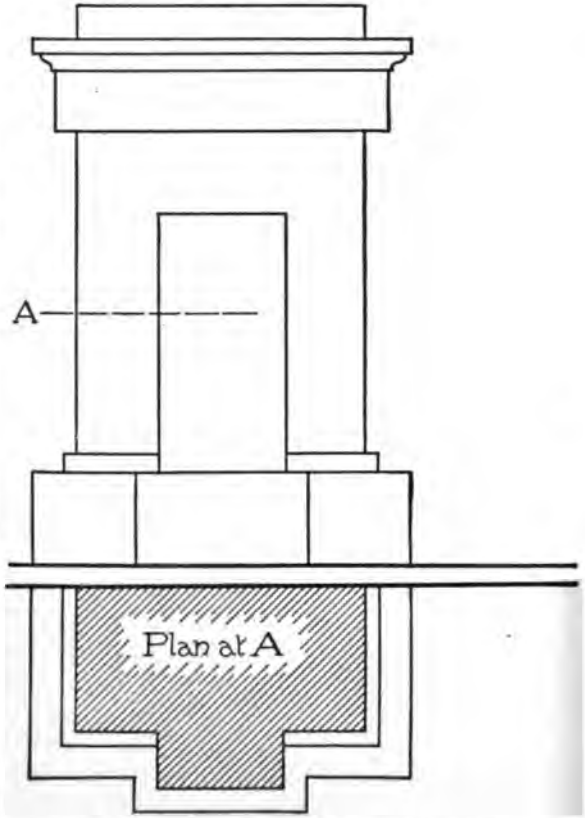
Find shade of objects and shadows on V and H.



DATE NAME

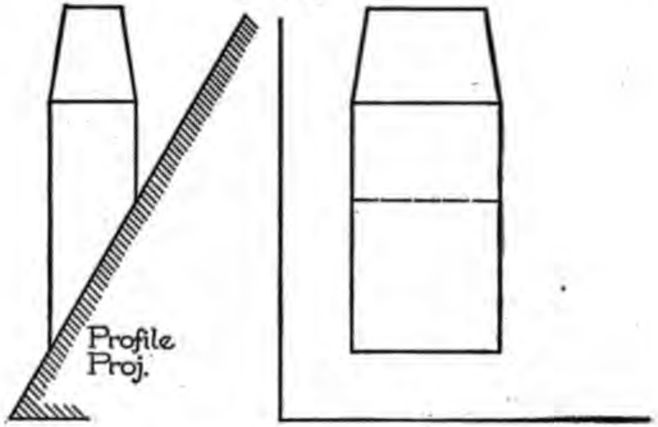
SHADES & SHADOWS

·22·

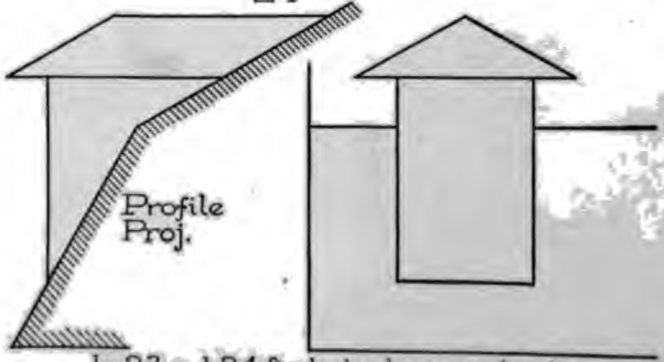


Find shadows of object on V and H

·23·



·24·



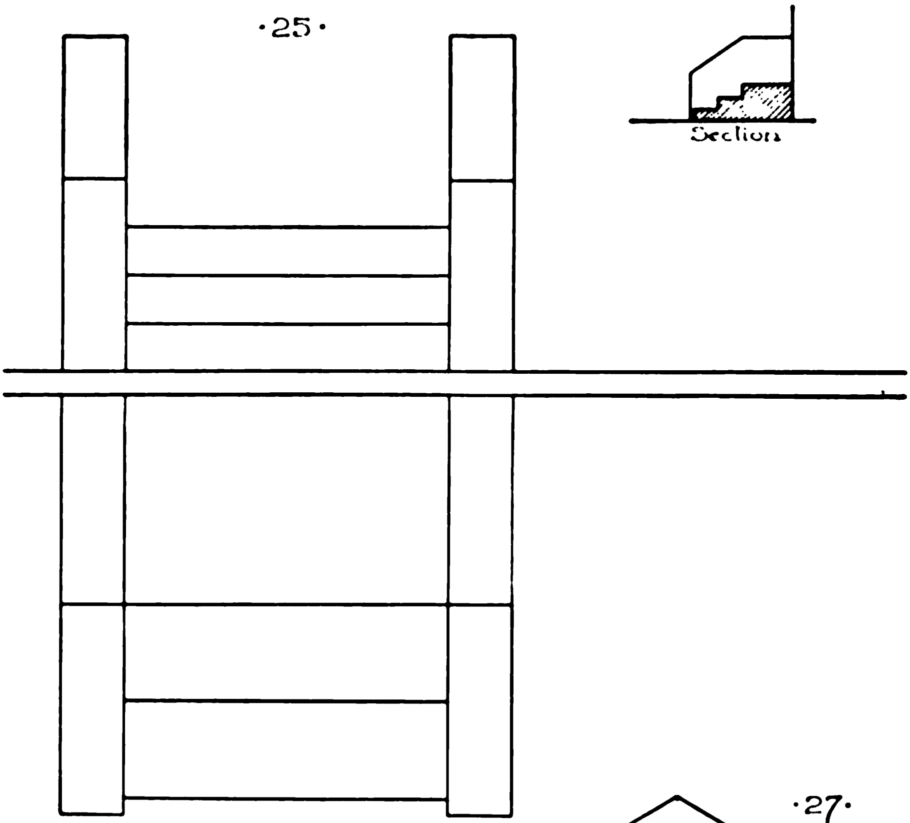
In 23 and 24 find shadows in elevation only.

DATE

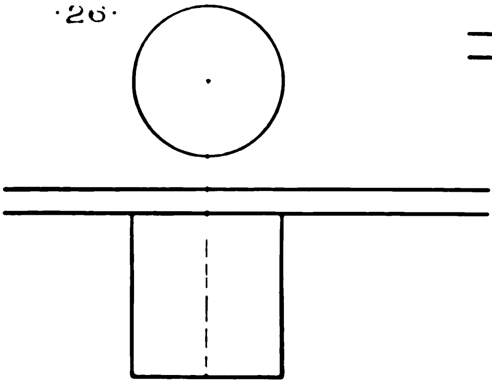
NAME

SHADES & SHADOWS PLATE V

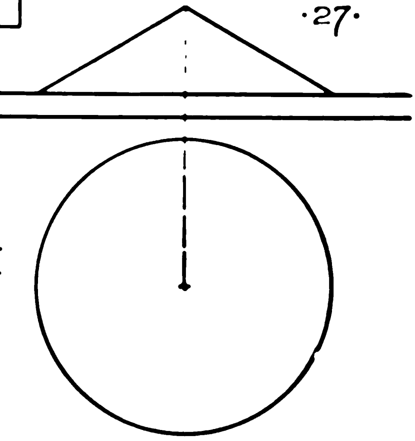
·25·



·26·



·27·

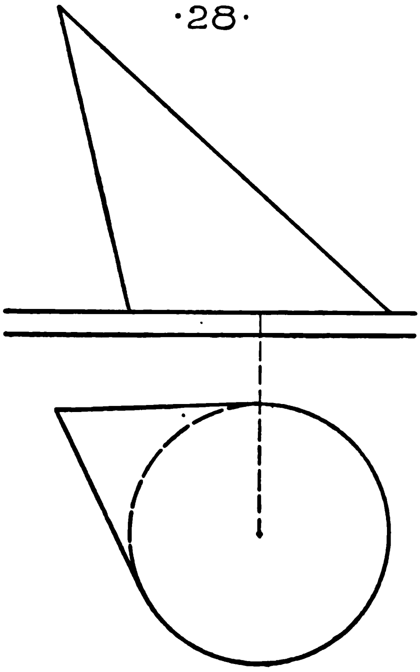


DATE NAME

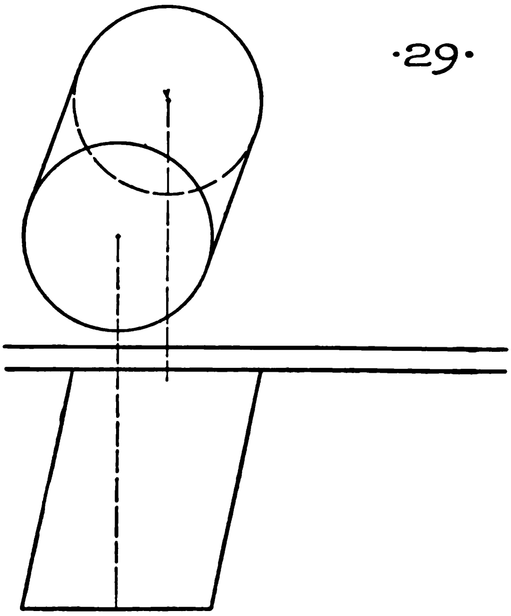
SHADES & SHADOWS

PLATE VI

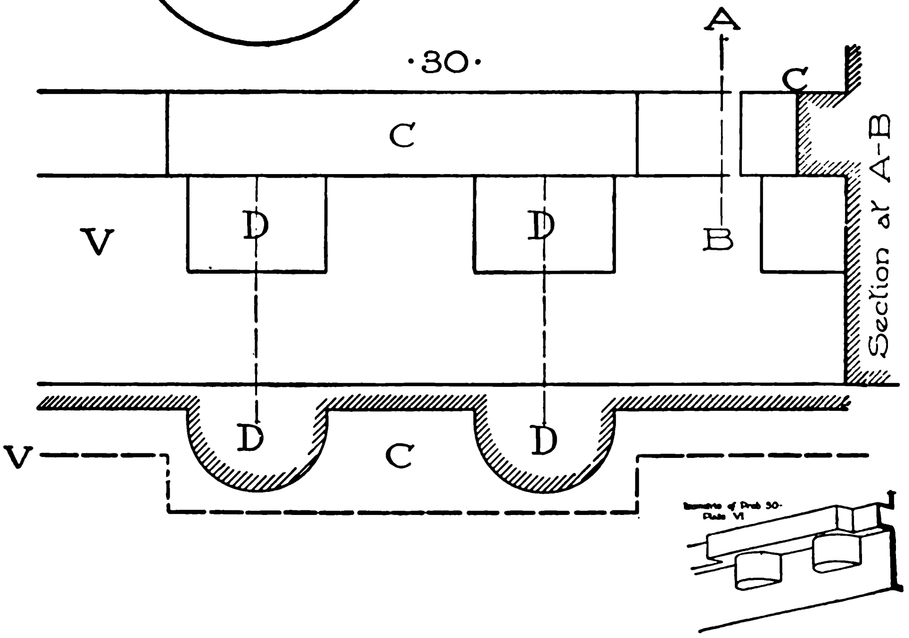
·28·



·29·



·30·



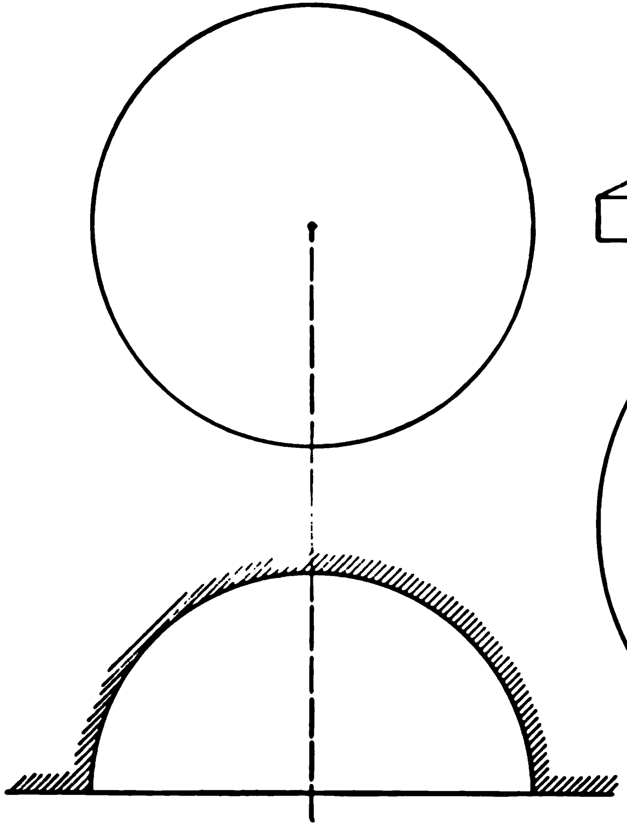
DATE

NAME

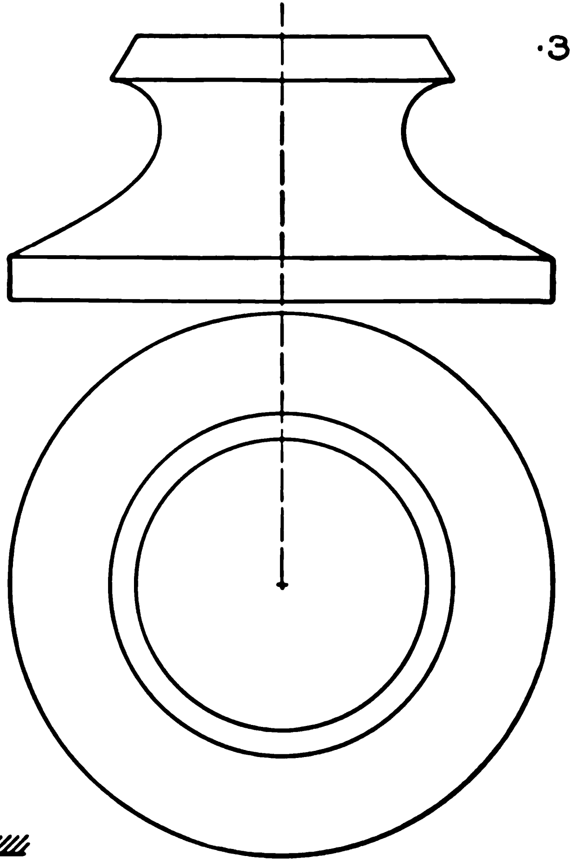
SHADES & SHADOWS

PLATE VII

·31·



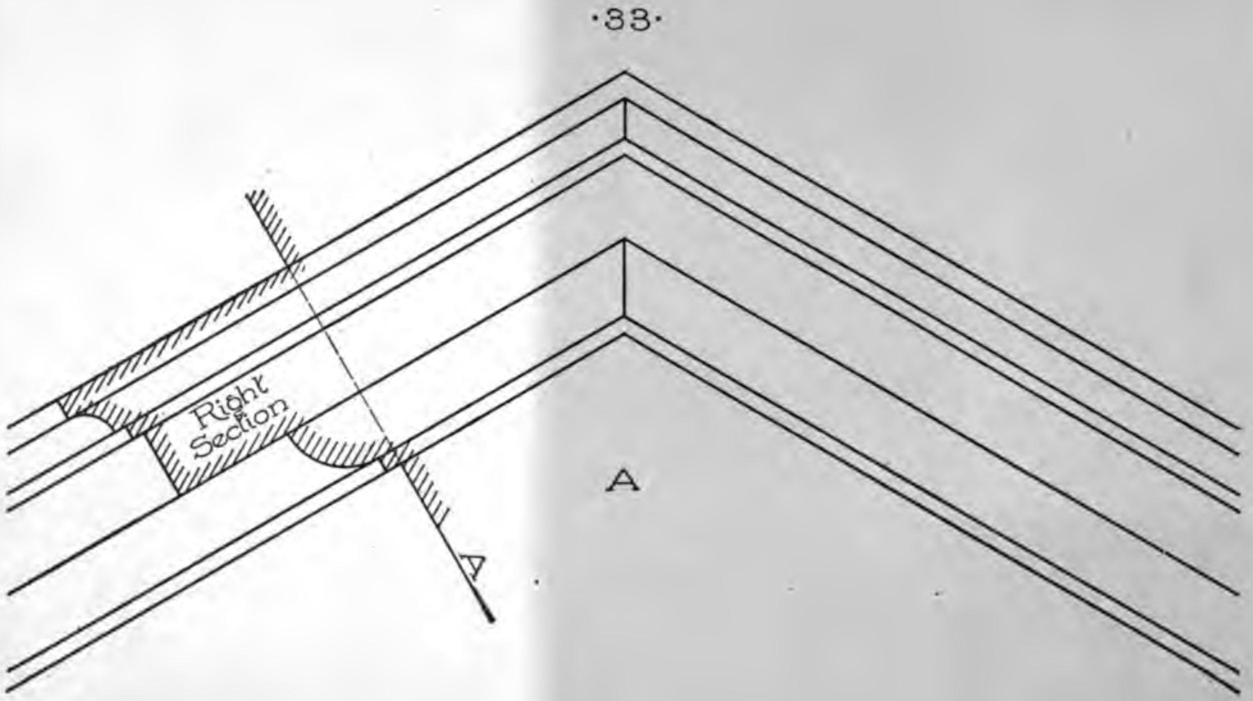
·32·



DATE

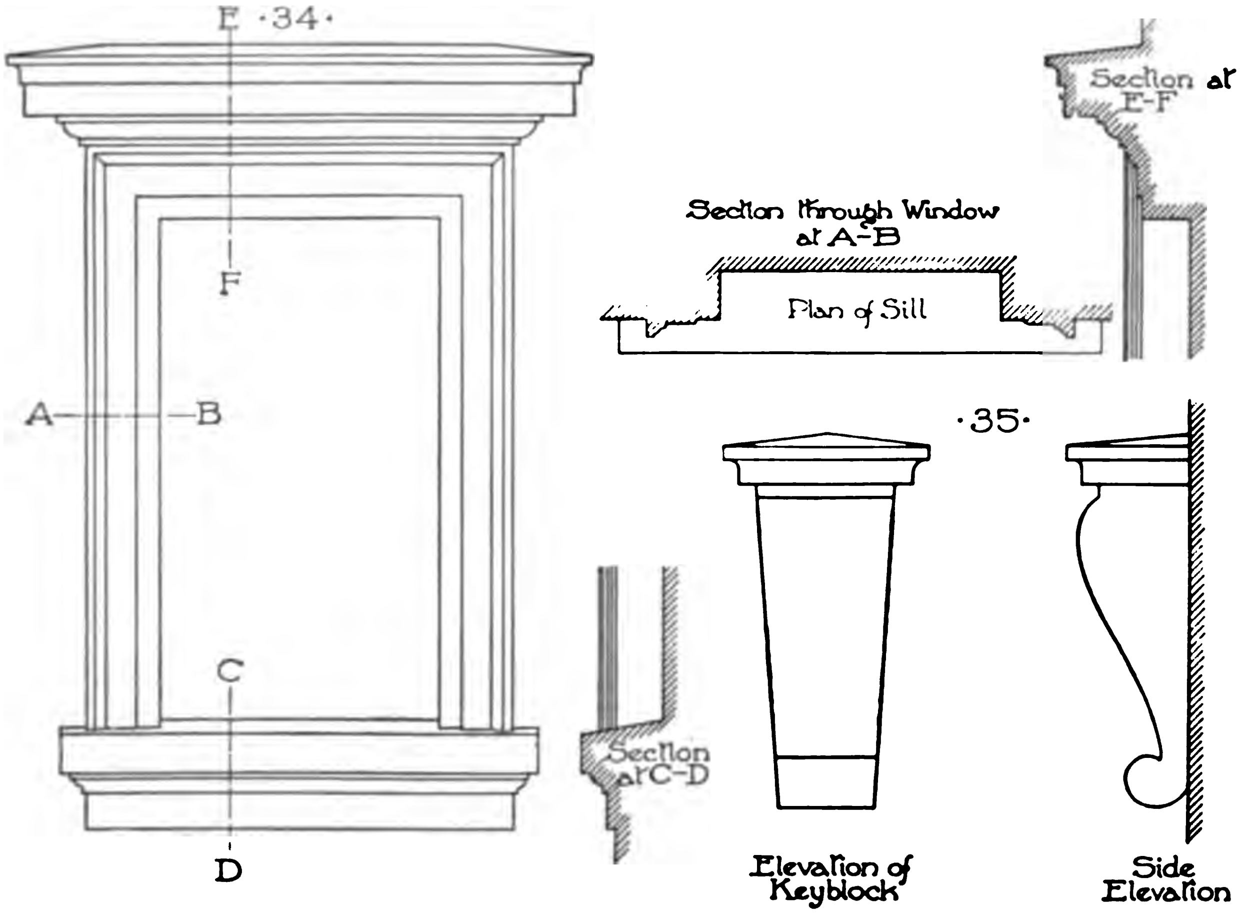
NAME

SHADES & SHADOWS PLATE VIII



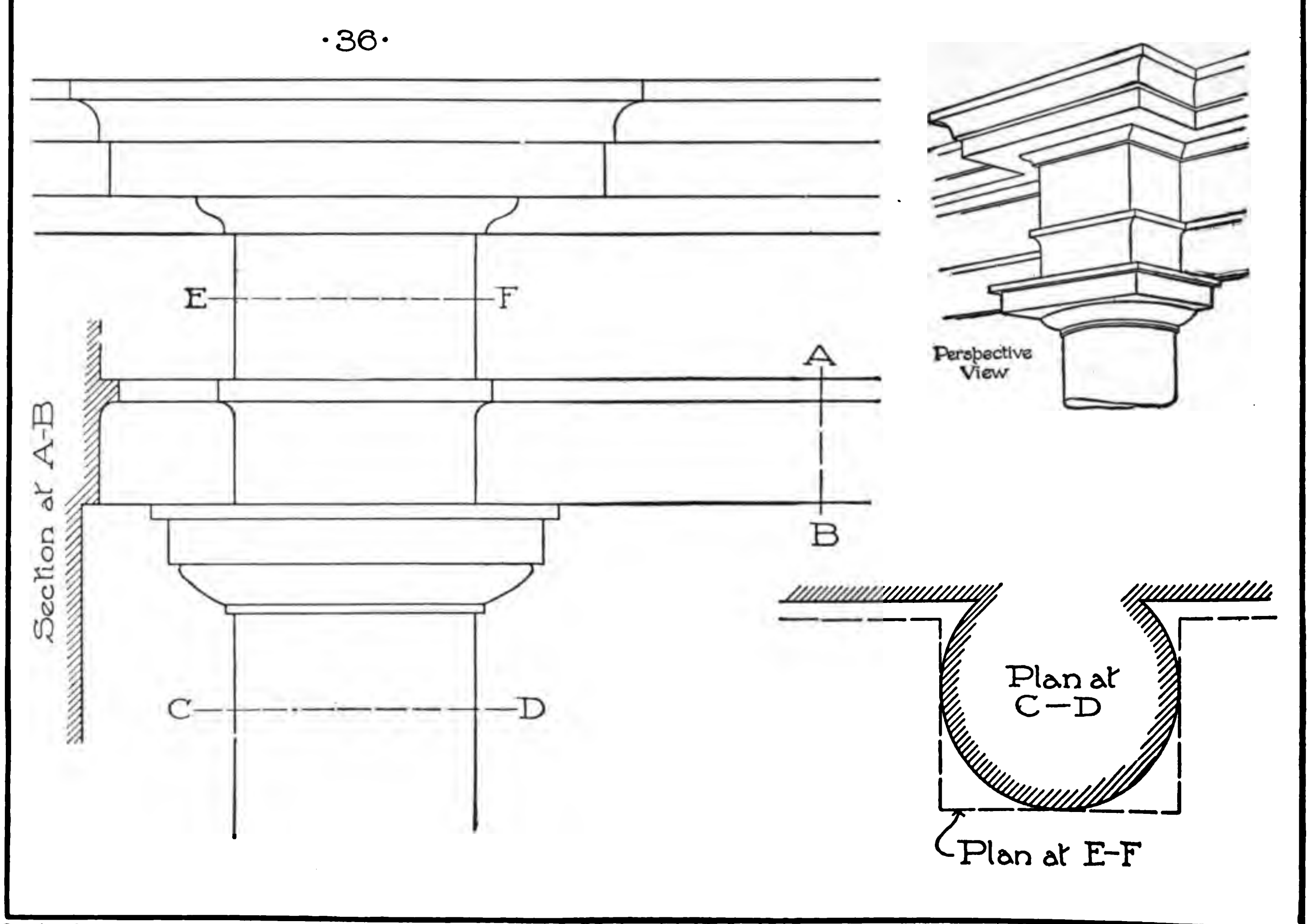
DATE NAME

SHADES & SHADOWS **PLATE IX**



DATE **NAME**

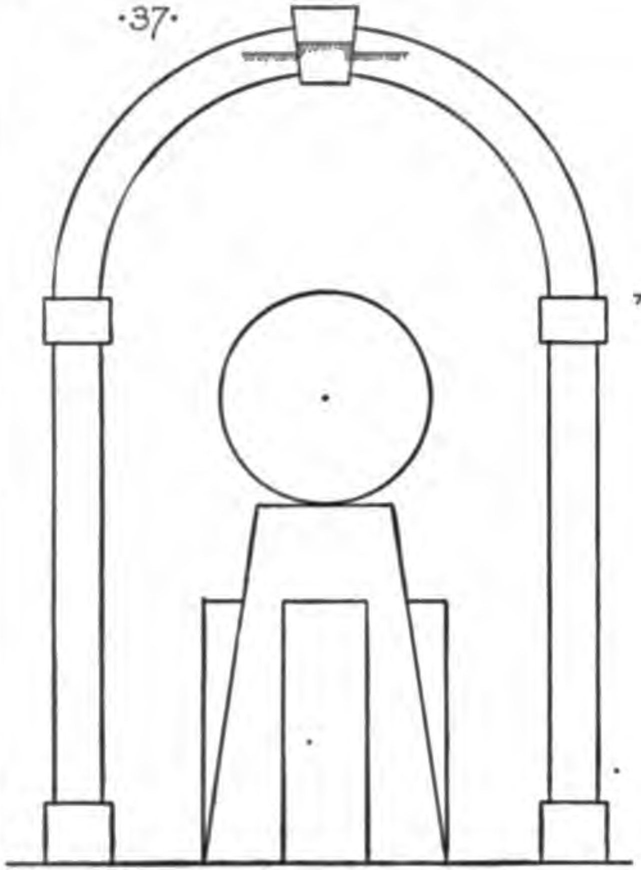
SHADES & SHADOWS PLATE X



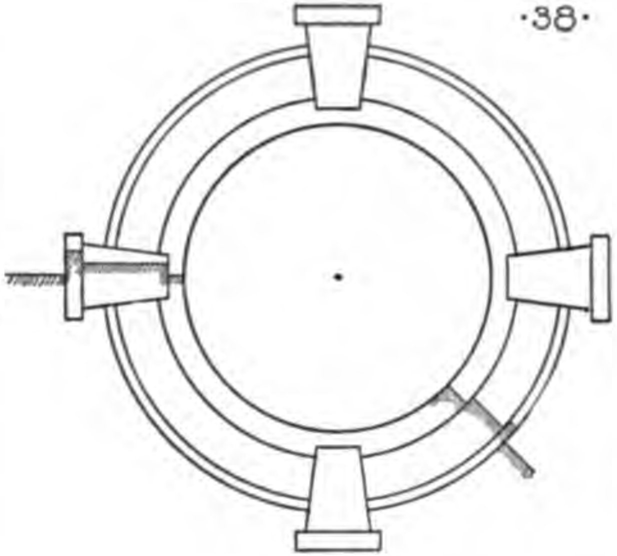
DATE NAME

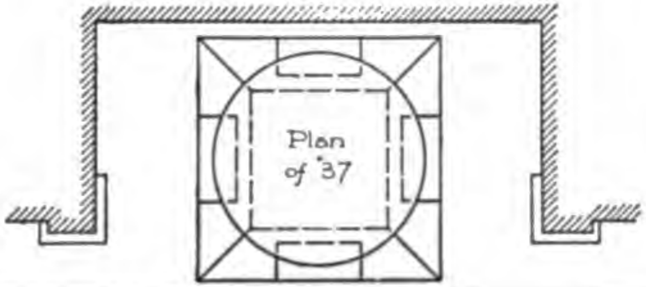
SHADES & SHADOWS PLATE XI

·37·



·38·



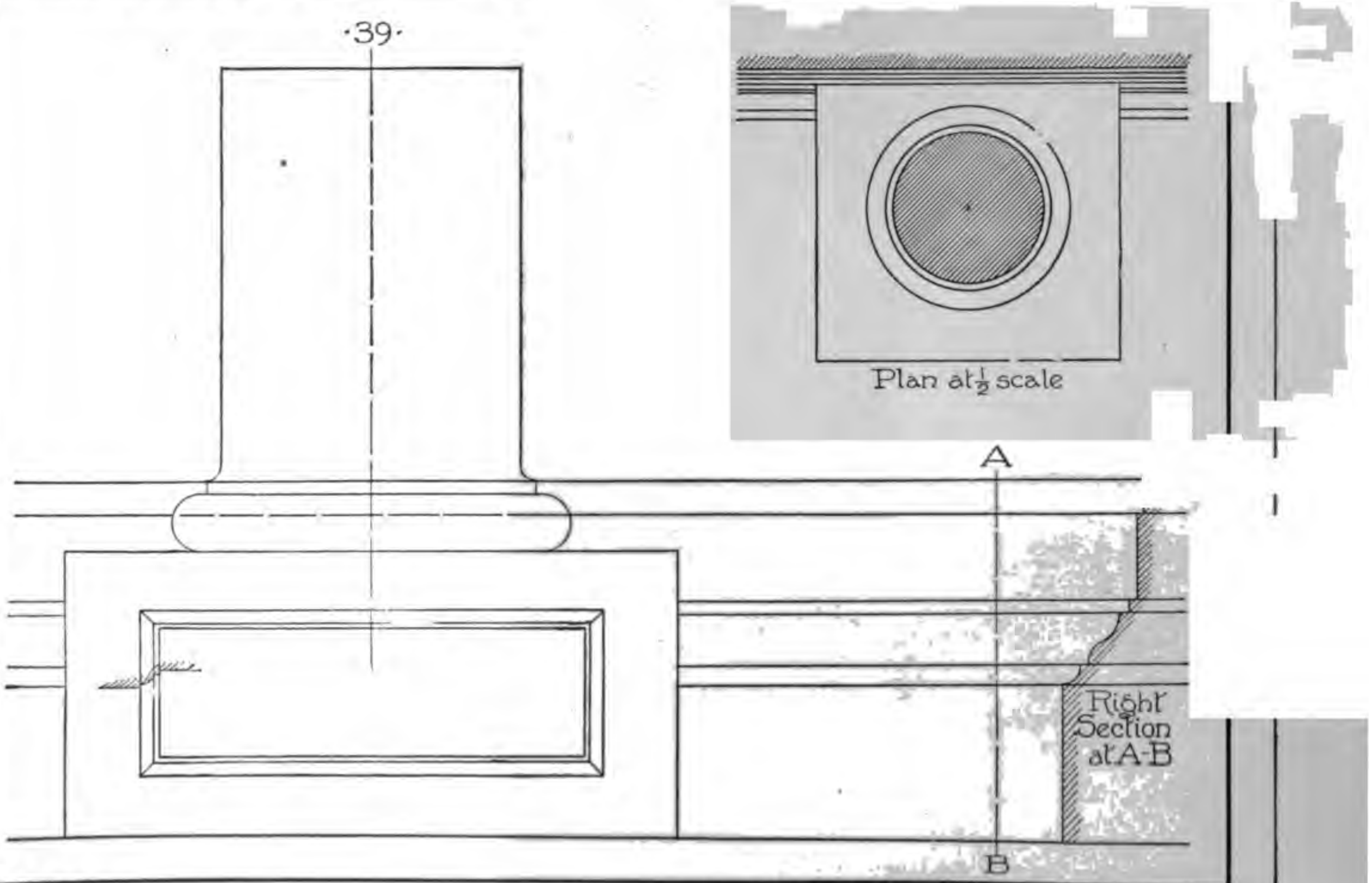


DATE

NAME

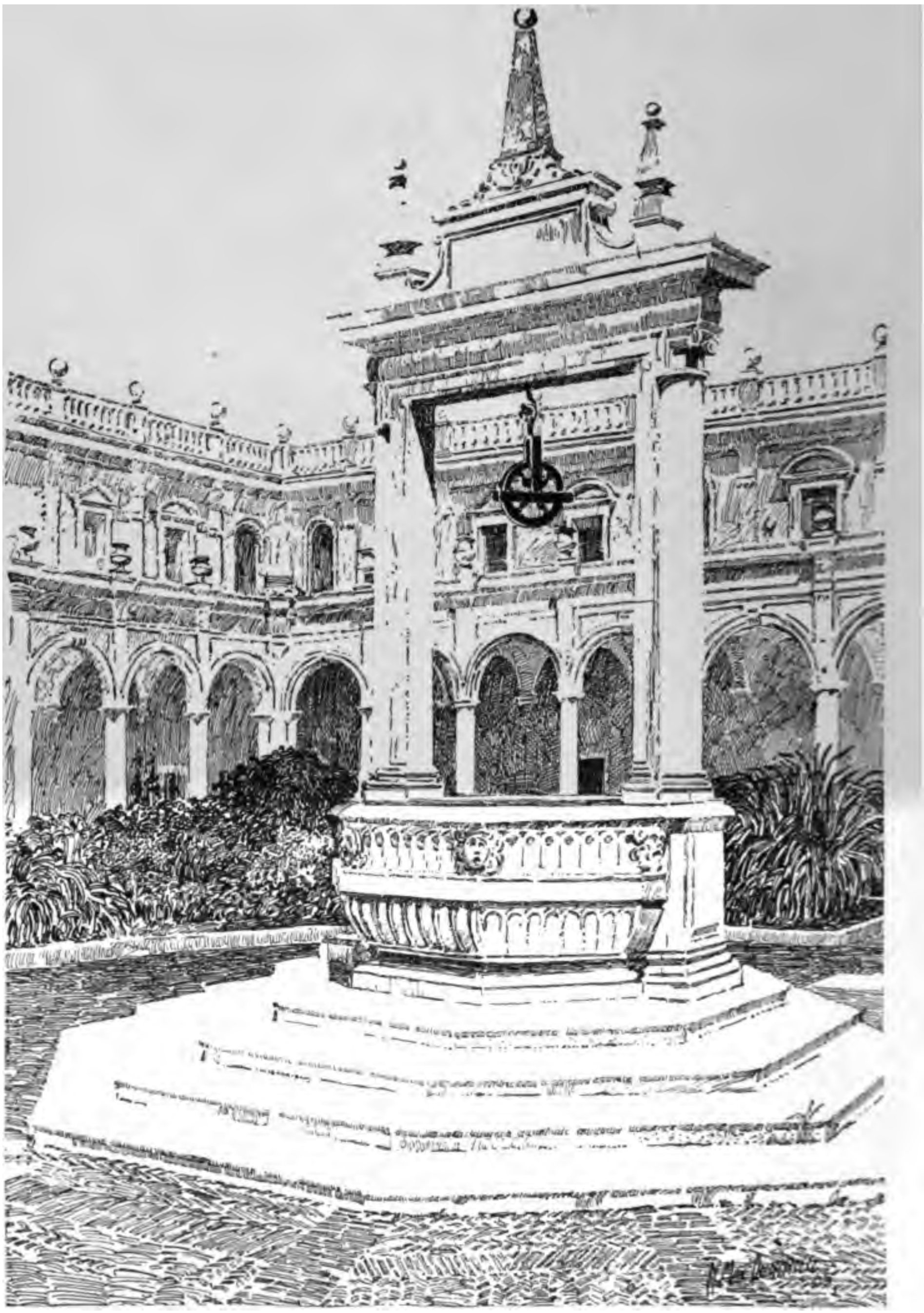
SHADES & SHADOWS

·39·



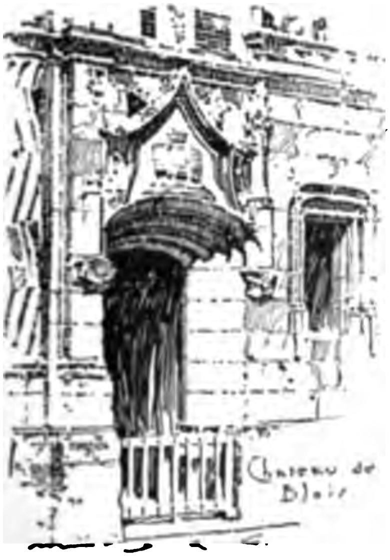
DATE

NAME



EXAMPLE OF PEN AND INK RENDERING
Drawing by N. Max Dunning, Chicago, Ill.

RENDERING IN PEN AND INK.



To render in pen and ink a large and important drawing is no small accomplishment. Usually years of experience are necessary before one can successfully undertake such drawings. Now and then a student is to be found having talent to the extent that the attainment of this skill seems a very easy matter, but in general this talent is comparatively rare. Ninety-five out of every hundred have a long task ahead before success is possible. This difficulty of attainment, however, makes the accomplishment all the more valuable. No one would expect to learn engraving on wood in a few brief lessons, and yet in pen and ink rendering difficulties are to be met not unlike those connected with engraving.

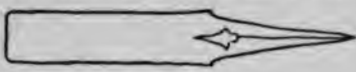
But there are many things concerning pen and ink work which can be readily learned; they are worth the trouble and the labor expended, and may prove useful. A consideration of these will, in any case, introduce the art and serve also as a good foundation for further pursuit of the subject if desired.

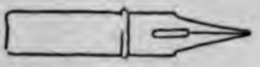
It is the purpose of this paper to seek the most modest of results, which may be set forth thus,- the rendering of a small building at a small scale in the very simplest manner, with few or no accessories.

Kind of Drawing. There are three ways in which a sketch may be rendered, viz: with pen, pencil, or brush. Pen rendering will be considered first, and later additional notes will be made as to pencil work. Rendering with the brush is another line of work, but much that may be advised in regard to pen rendering would also apply to brush work.

MATERIALS.

Pens. The tendency of beginners is to use too fine a pen. It must be remembered that many pen drawings are reproductions much smaller than the originals, and consequently the lines appear much finer than in the drawing itself. There are two pens that can be recommended, shown herewith. Years of experience prove them to be perfectly satisfactory. Occasionally a finer pen is needed, such as Gillott No. 303. The Esterbrook No. 14, a larger pen, is necessary in making the blacker portions of a drawing. The Gillott 404 is to be used for general work in the same drawing.


ESTERBROOK BANK PEN, NO. 14.

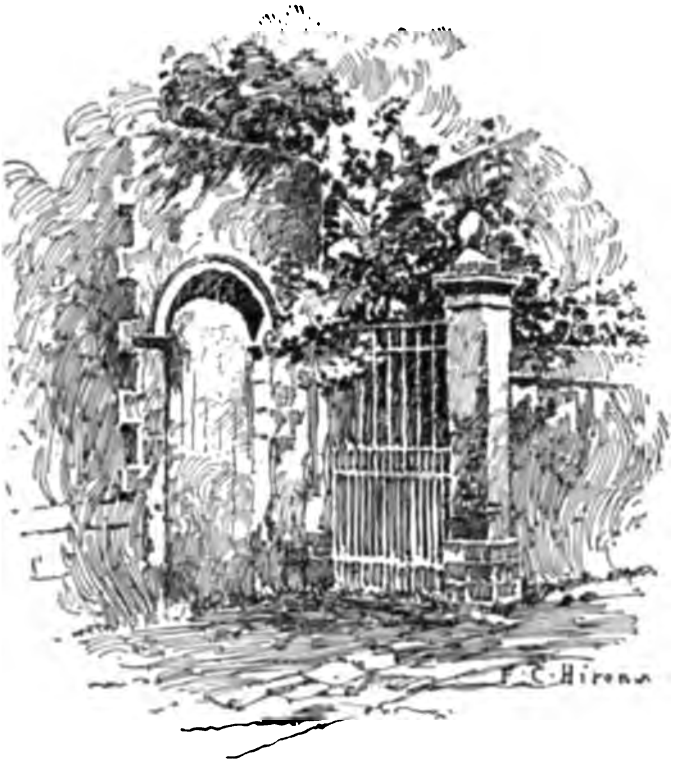

GILLOTT NO. 404.

Ink is not of as much importance as pens. The various prepared India inks put up in bottles are all that can be desired. They are more convenient than ink that must be rubbed up, and they have the advantage of always being properly black. Some ordinary writing inks serve the purpose very well if reproduction is not an object, but if reproduction is desired, India ink, being black, is preferred.

Paper. The very best surface is a hard Bristol board. The softer kinds of Bristol boards should be avoided, as they will not stand erasure. Most of the drawing papers do very well. Whatman's hot pressed paper is very satisfactory. An excellent drawing surface is obtained by mounting a smooth paper on cardboard, thus obtaining a level surface that will not spring up with each pressure of the pen. This is equivalent to a Bristol board. However, the size of Bristol board is limited and frequently drawings must be much larger, in which case the mounted paper is a necessity.

LINE WORK.

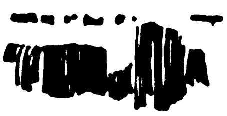
Quality of Line. Too much stress cannot be laid on the importance of a good line, however insignificant it may seem. Care in each individual line is absolutely necessary for good work. A line



GOOD QUALITY OF LINE.

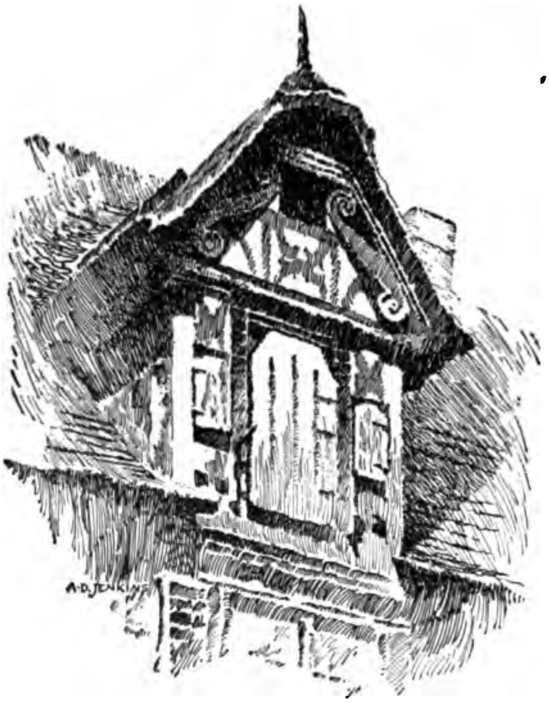
that is stiff and hard, feeble, scratchy or broken, will not do. Such work will ruin a drawing that in other respects may be excellent. The accompanying illustration by one of the students of the Massachusetts Institute of Technology is an example of excellent quality of line. Each line, even to the very smallest, has grace and beauty. By a very few, the ability to make such lines is speedily acquired—but by a few only—others may attain it by careful practice.

Every line of a drawing—the outline of the building and each line of the rendering, even to the very shortest must be done feelingly, gracefully, positively. Usually a slight curve is advisable and if long lines are used, a quaver or tremble adds much to the result. Each line of a shadow should have a slight pressure of the pen at the lower end. This produces a dark edge in the group of lines that



make the shadows, giving definiteness to the shadow and contrast to the white light below it.

Method. The combination of individual lines produces what we may term a method. The individual line may be good but the combining may be unfortunate. In making a wash drawing no thought is necessary concerning the direction of the wash, but in using lines at once the query arises as to what direction they shall take. A method is something one must grow into from a small, simple beginning. The accompanying illustration, the work of another Massachusetts Institute of Technology student, is an example of rare skill in method quickly acquired. There is an utter absence of anything rigid or mechanical in the whole. Observe how softly the edges of the drawing merge into the white of the paper. The vigor of the drawing is gathered in the dormer itself.



A DORMER, GERMANY.

EXCELLENT METHOD

Vertical Lines. The simplest method is obtained by the use of the vertical line. Some drawings can be made entirely by this means. See Fig. 3, every line of which is vertical. This illustrates the value of a good individual line. It will be observed that although vertical, these lines are not severely straight and stiff, they tremble a little, or have a slight suggestion of a curve. In the shadow at the bottom of the drawing each line is emphasized at the top by a slight pressure, and made thin at the lower end in order to soften off the edges of the drawing as a whole.

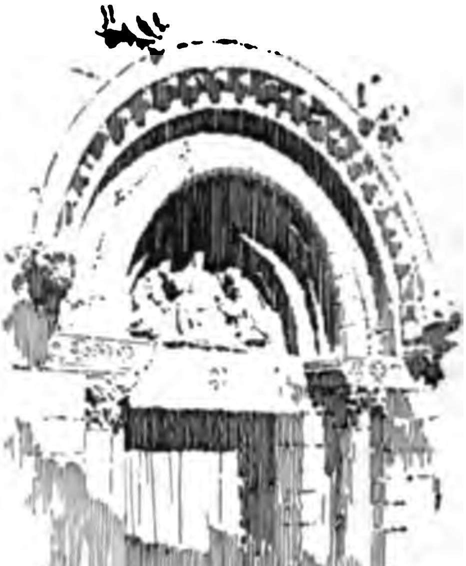


Fig. 3.

VERTICAL LINE METHOD.

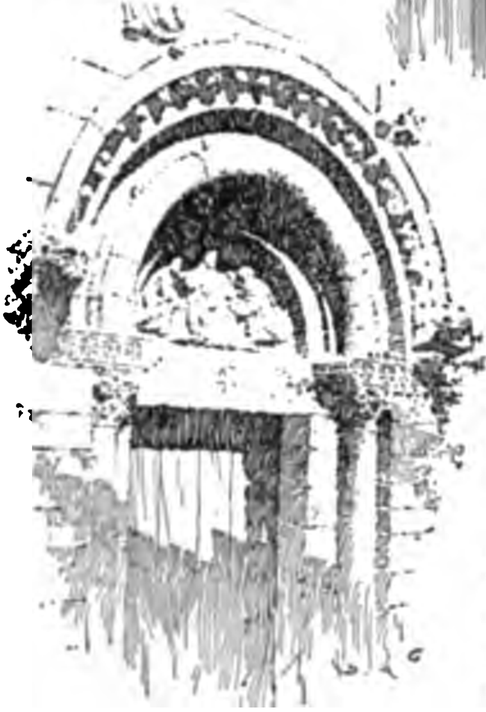
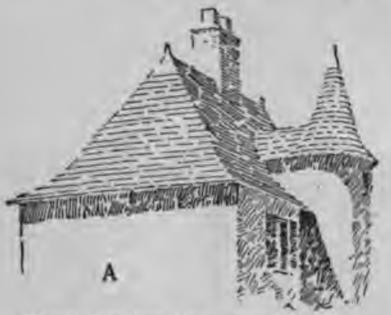


Fig. 4.

FREE LINE METHOD.

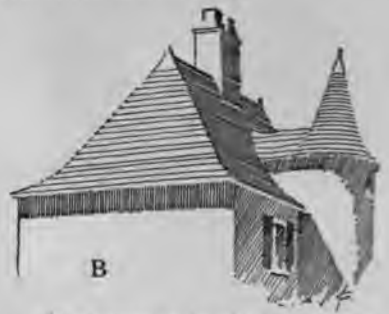
Free Lines. Fig. 4 shows another method. The vertical line is discarded and the freest possible line is used. No one direction is followed, but the lines go in any or all directions. Which is the better method? The answer doubtless must be that the free method is the least conspicuous. It is better adapted for general use, in the showing of various surfaces and textures.

VARIOUS EXAMPLES OF BAD METHODS.



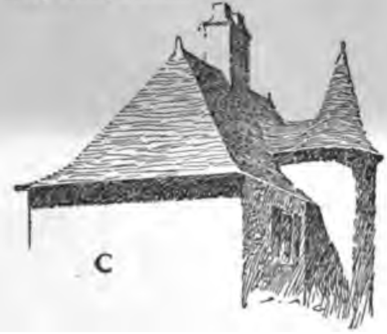
A

Short, broken line, resulting in a spotty effect; a fault common with beginners. The white spaces between the ends of the lines are very conspicuous.



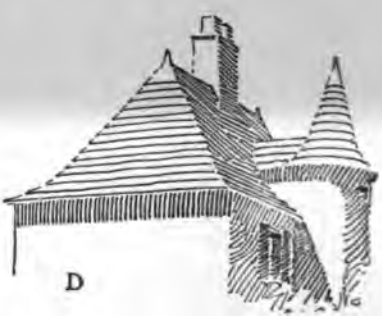
B

The opposite in character to A. Long, unbroken lines, but so severely straight as to be hard and dry in general appearance.



C

Short lines, individually they may be very good, as they curve freely, but the combination is fussy and finnicky.



D

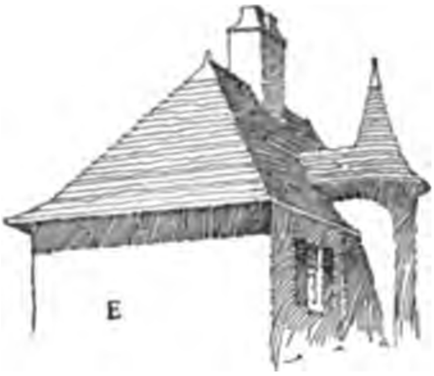
Direction of line not bad, but is rather too coarse to be agreeable. Wide spacing of lines on light portions add to the coarse result.

These illustrate four bad methods. A has the least merit, the others approach to a fair quality. In E an effort is made to avoid all the faults shown in the others—the short or severely straight line, the over labor combination of C, and the coarse line of D.

LIGHT AND SHADE.

Values. If several lines are drawn parallel and quite close together, but not touching, a gray, or half-tone value is the result.

Lines drawn so close together that the ink of one runs into that of the other, with little or no white space between, give a black value. The white of the paper untouched by the pen gives a white value. Fig. 5 shows only two values—black and white; Fig. 6 also has two,—gray and white; Fig. 7 has the three,—black, gray and white. The first is harsh, the second is pale, and the third seems most satisfactory.



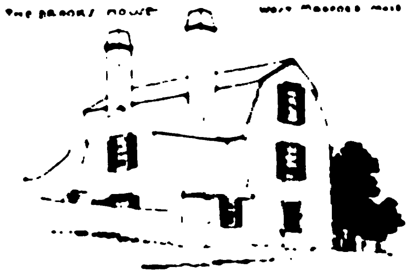


Fig. 5.
BLACK AND WHITE.

This is a safe rule to follow—get into every pen drawing, black, gray and white. Usually, in early attempts, there is a tendency to omit the black. Look for the place in the

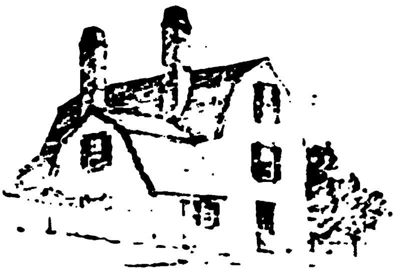


Fig. 6.
GRAY AND WHITE.

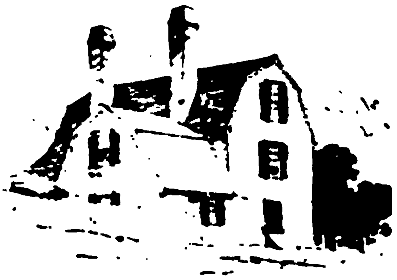


Fig. 7.
BLACK, GRAY AND WHITE.

drawing where [illegible]; you are not likely to get too much of it. [illegible] gray be rather light, midway in strength [illegible] whi[illegible]k. A heavy half tone is

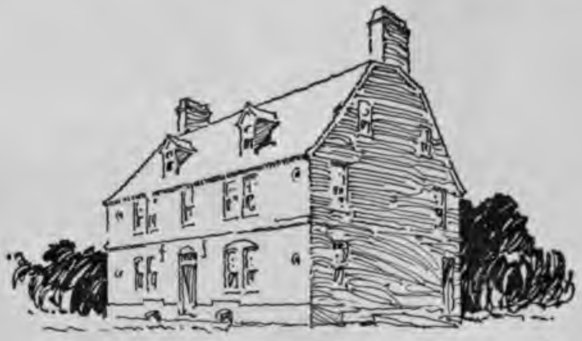


Fig. 8.
ONE SIDE IN SHADE.

a dangerous value. The black may often grade off into the gray, or there may be distinct fields or areas of each value.

Lighting. The first thing to consider in the rendering of an architectural subject is the choosing of the direction of light. Sometimes when the building is turned well to the front, showing a sharp return of the end, it may be best to put that side in shade, Fig. 8, but it is not necessary. Values may be obtained by other means such as by shadows, or color of material. It is not wise to attempt a heavy rendering in pen work. Usually it is safer

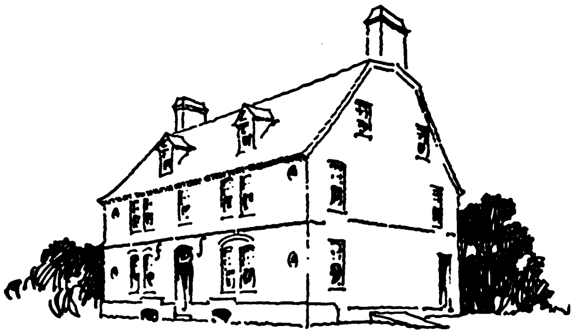


Fig. 9.
ALL IN LIGHT.

to keep both sides of the building in light as shown in two of these sketches, Figs. 9 and 10.

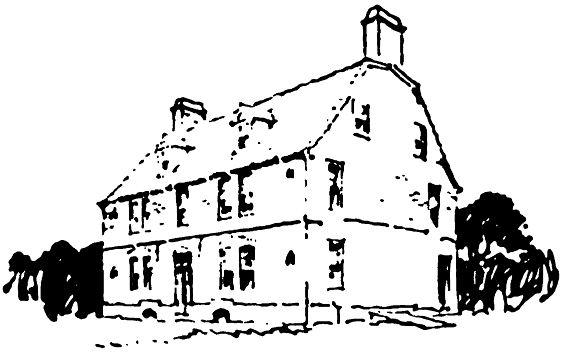


Fig. 10.
ALL IN LIGHT WITH HALF-TONE VALUE TO ROOF.

Color of Material. One of the means by which values may be introduced into a rendering, is by considering the color of the material of which the building is constructed.

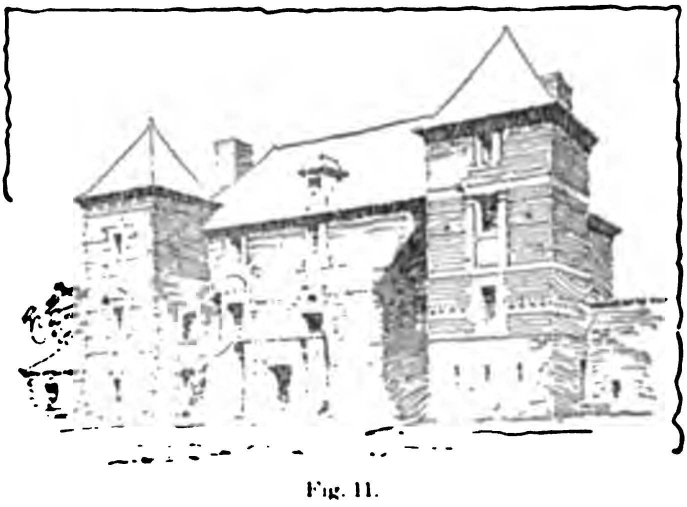


Fig. 11.
HALF TONE WALLS

In this example, Fig. 11, we may first use the brick walls as a place to locate a gray value. In the second example, Fig. 12, the roof is used for the same value. For the very dark or black value we must depend on the shadows. Neither one of these drawings is wholly satisfactory. In the first, the roof, and in the other, the walls, seem too glaringly white. For that reason it is not always best to use the material color so broadly. To give color to both walls and roof would destroy the white value, and the white value must not be lost. Fig. 13 shows an attempt at a compromise.

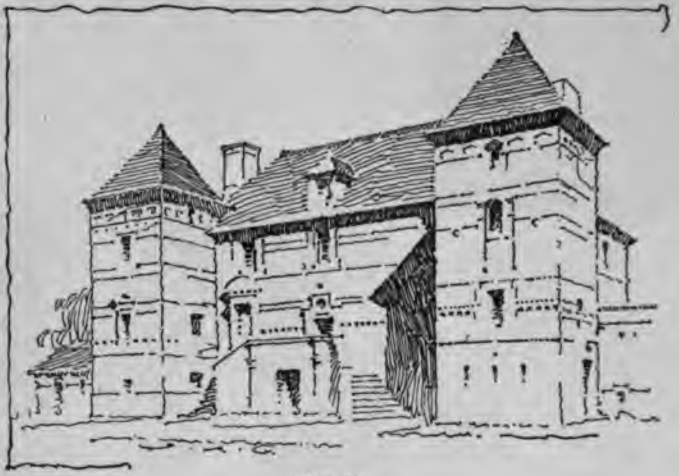
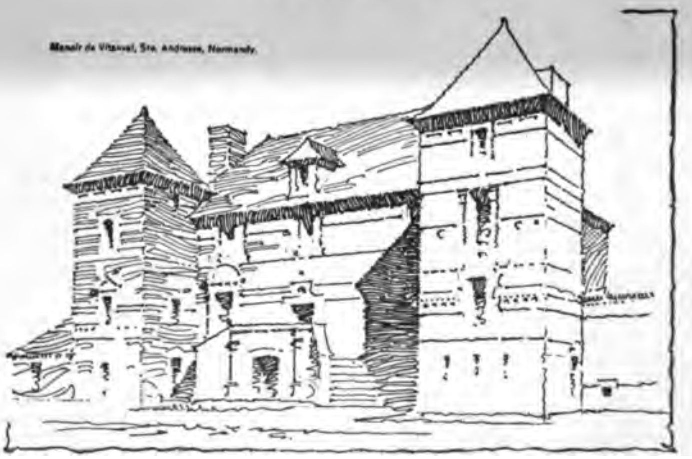


Fig. 12.
HALF-TONE ROOF.



Manoir de Vitanval, Ste. Andresse, Normandy.

Fig. 13.
A COMPROMISE.

Shadows Only. The simplest means for obtaining values is by the use of shadows. Sometimes the shadows alone will complete a drawing in a very satisfactory manner, as in Fig. 14. Some of the shadows may be made gray, and others black or nearly so, in order to get the needed variety in values.

A building like that shown in Fig. 15, The Alden House, is not favorable to shadows only. It has no porch or other projection sufficiently large to cast a strong shadow. In such a case a little accessory helps one out of the difficulty, and a little rendering of the material gives needed half tone. Otherwise the drawing would be too white.

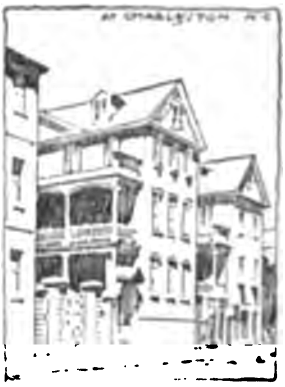


Fig. 14.
SHADOWS ONLY.

Principality or Accent. We now enter into a matter of composition. One simple rule will be given and there is none more useful. Let there be one place in the drawing where a strong accent of black shall exist. It may be one black, or it may be a group of them. This accent will be found in nearly every illustration in this paper. It is usually best to get the accent in the building itself, by the aid of some large shadow perhaps, but when there is no chance for this it may be necessary to get it in an accessory such as foliage. This is shown in Fig. 16, a drawing of a barn. In connection with this black accent let there be a large white area if possible. A princi-

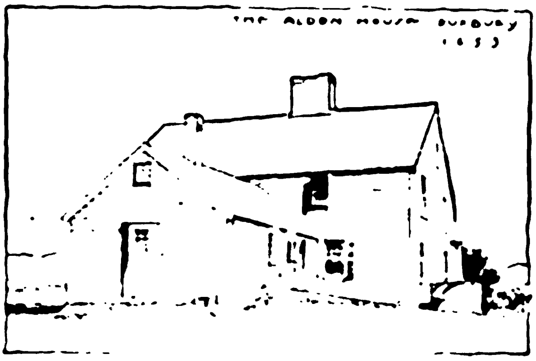


Fig. 15.

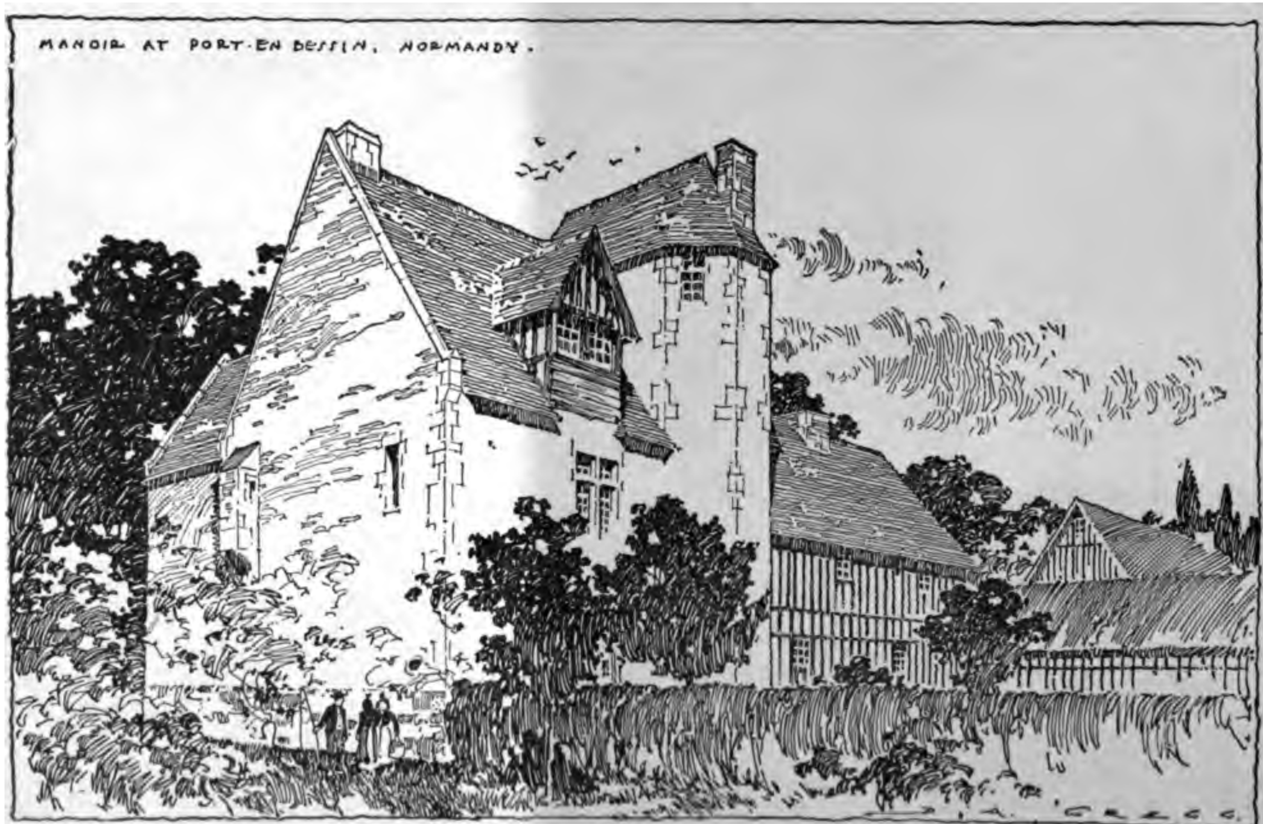

MANOIR AT PORT-EN BESSIN. NORMANDY.
J. A. GREGG.

Fig. 17.

pal white, as well as a principal black is thus obtained. Most drawings permit the dark accent and the light area also.

Fig. 17 is rendered to a greater extent than should be attempted by the student in this course, but it may be helpful to call attention to some things in its composition.

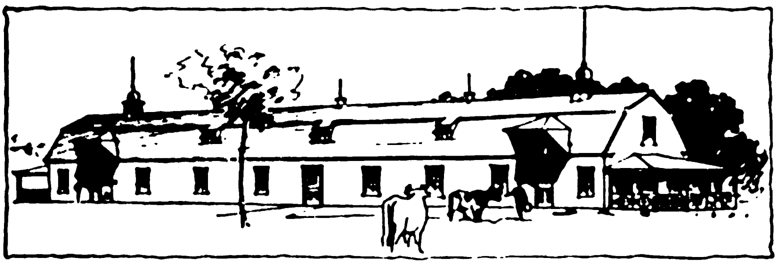


Fig. 16.

The location of the dark accent is apparent in the trees at the left. The other blacks, the trees in front of the building and those down at the extreme right, simply repeat in diminishing force and size, this first dark accent. The light area of the drawing is as distinctly shown as the dark accent; in fact this large light is the feature of this rendering. The light brick rendering of the gable is necessary to confine the light a little more surely to the important portion of the wall. Also, if this light rendering were omitted the building would appear unpleasantly white.

The half tone of the roof is necessary to give a soft contrast to the light wall surface. The sky has its use. Cover it up, and see how the whole subject slumps downward.

Last, but not least, observe that the corners of the drawing are kept free from rendering. This is usually safe. Let the rendering of every sort gather about the central object. The corners of a drawing may then be left to take care of themselves.

PENCIL WORK.

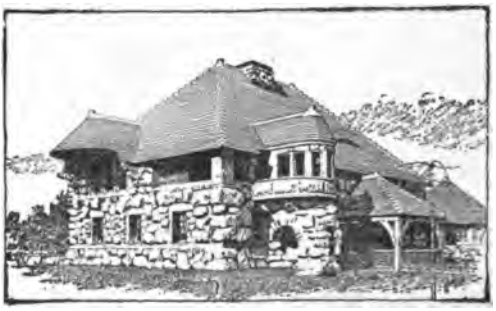
A pencil is a quicker medium for the rendering of a sketch than a pen. A pencil sketch may be made directly on a sheet of drawing paper, and completed on that same sheet. But it is neater to first draw the perspective on smooth white paper, then place Alba tracing paper over this outline, and trace and render. By this means all construction lines in the layout can be omitted, and the sunny edge of projections can be left out, thus adding greatly to the brightness of the drawing.

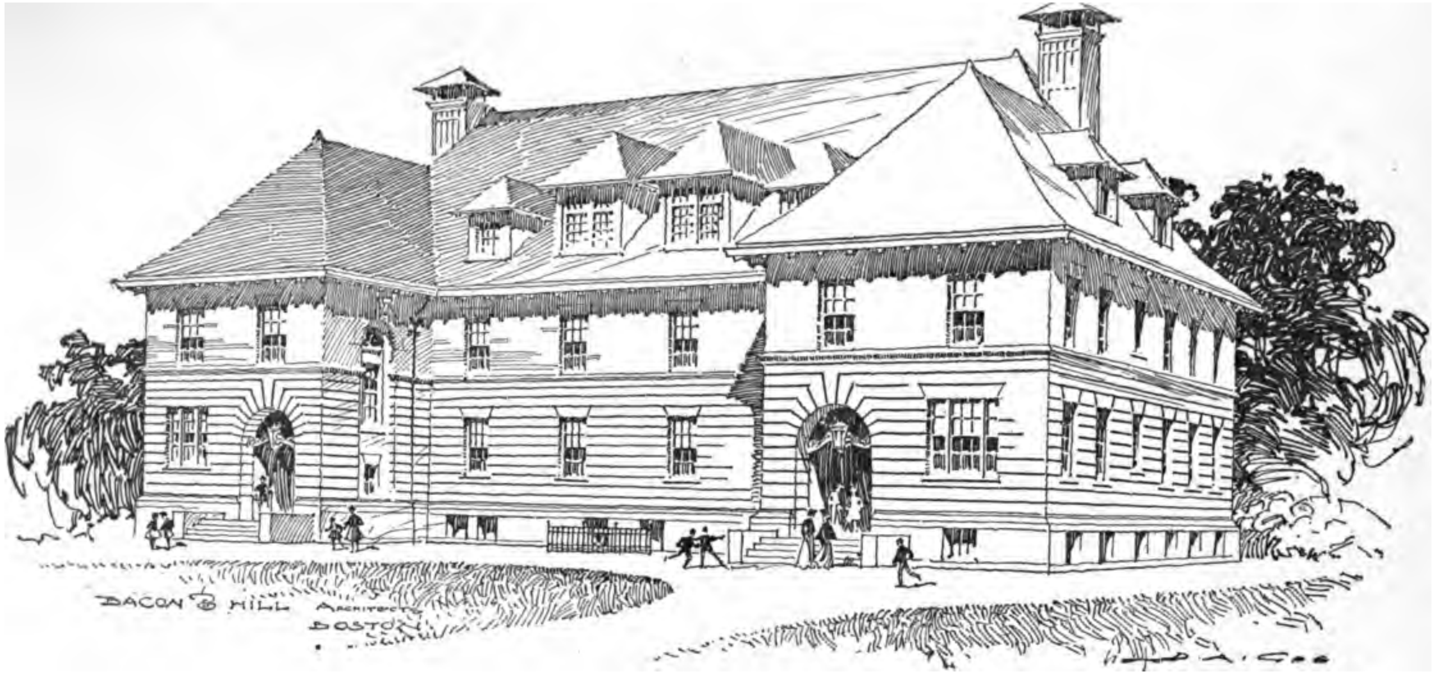
Use a soft pencil for rendering, a BB or softer. If the drawing is to be much handled, spray it with fixatif. Trim the sketch, lightly gum the corners, and lay on white card with good margin.

SUMMARY.

The following summary of advice for the rendering of work generally, with pen or pencil may be found helpful.

1. Consider the direction of the light.
2. Discover in the outline before you. the opportunity for a leading dark accent.
3. Look out also for the location of a large light area.
4. Put in shadows.
5. Get at least three distinct values; black, gray and white.
6. Consider the color of roof or the wall, and if necessary use one of them or portions of each for a gray value.
7. Use a very free method.
8. Keep rendering out of the corners of the drawing.





A STUDY IN PEN AND INK RENDERING

For criticism of this drawing see back of page

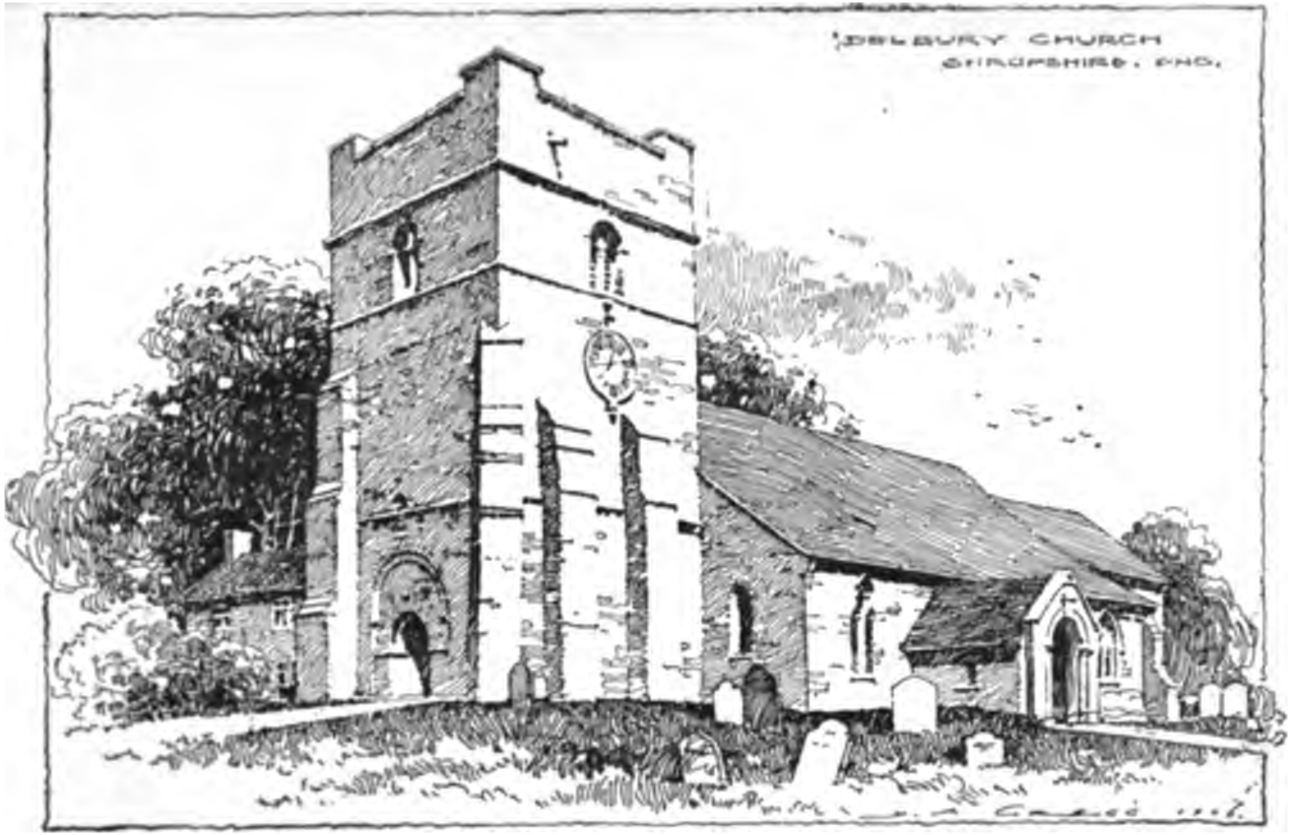
SCHOOL HOUSE*

to [illegible] n [illegible] a [illegible] here used that is very frequently
le and [illegible] *i. e.*, [illegible] of a large light effect on the near
[illegible], but one of good area. The color
v[illegible] roof [illegible] ignored in order to get this large
. It is obta[illegible] thoughtfully around it.
[illegible] he leading dark value, in the tree,
re[illegible] in [illegible] y in [illegible] windows, shadows, etc.
[illegible] that [illegible] up agreeably, just enough to bal-
[illegible]

to [illegible], strive for [illegible] direction and to avoid a hard liney
[illegible] ver possible the [illegible] ny [illegible] es are not drawn in by a line, the rendering itself producing sufficient definition. Again, note the distinct values, black, gray and white.

---

* The illustration referred to will be found on the back of this page.



A STUDY IN PEN AND INK RENDERING

For criticism of this drawing see back of page

DELBURY CHURCH*

As ever recommended, a free flowing line and method are used in every part of the drawing. On sunny edges (see buttresses) the line is omitted entirely.

As to difference in values, the black, gray and white are distinctly marked.

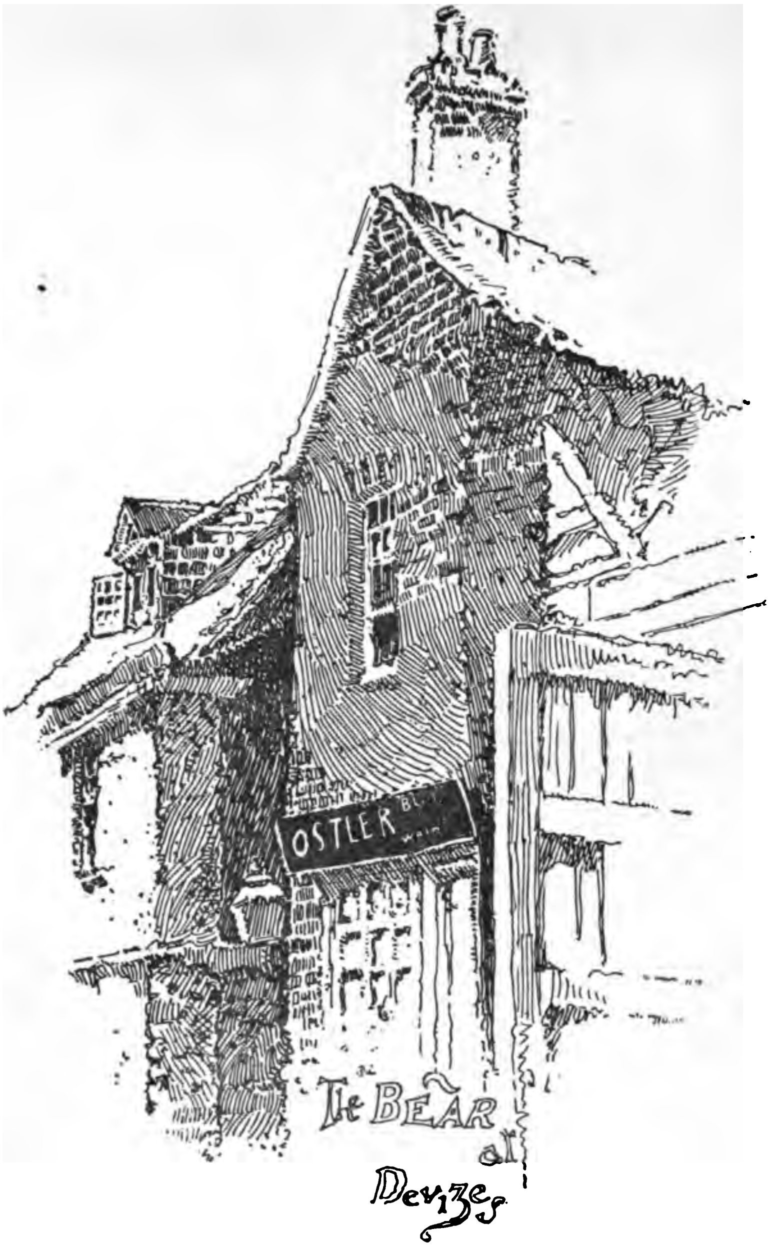
In composition, the large black of the tree is the leading accent, and its black is repeated in small areas in various parts of the work.

The subject affords as well a large leading light on the side of the tower, repeated also.

Again (and this is very important), the corners of the drawing are left untouched, which gives a quiet grouping of all the values.

---

* The illustration referred to will be found on the back of this page.



A STUDY IN PEN AND INK RENDERING

For criticism of this drawing see back of page

Copy of a drawing by Herbert Railton, an illustration in the English Illustrated Magazine in an article entitled "Coaching Days and Coaching Ways," Macmillan & Co., Publishers, by permission. This copy made by J. A. Kane, Pen and Ink Class. Massachusetts Institute of Technology, D. A. Gregg, Teacher.

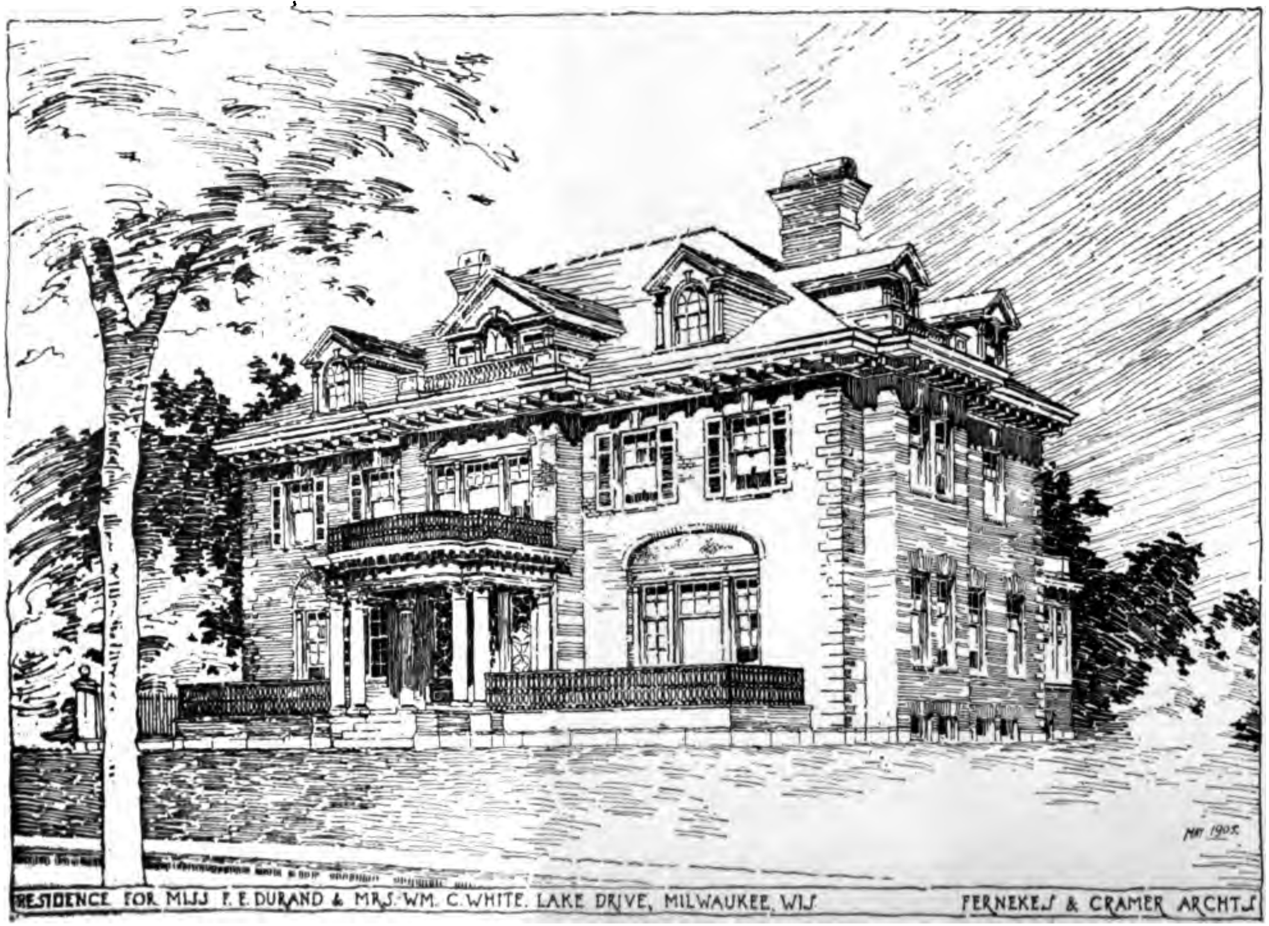
THE BEAR AT DEVIZES *

Probably no draftsman living can surpass Herbert Railton in brilliant technique, the free use of line, and ingenious method. His work is especially adapted to architectural illustration.

It will repay good effort to copy this with care. This copy retains most commendably the spirit of the original. Observe the absence of purely straight lines, and the great freedom used in all outlines.

---

* The illustration referred to will be found on the back of this page.

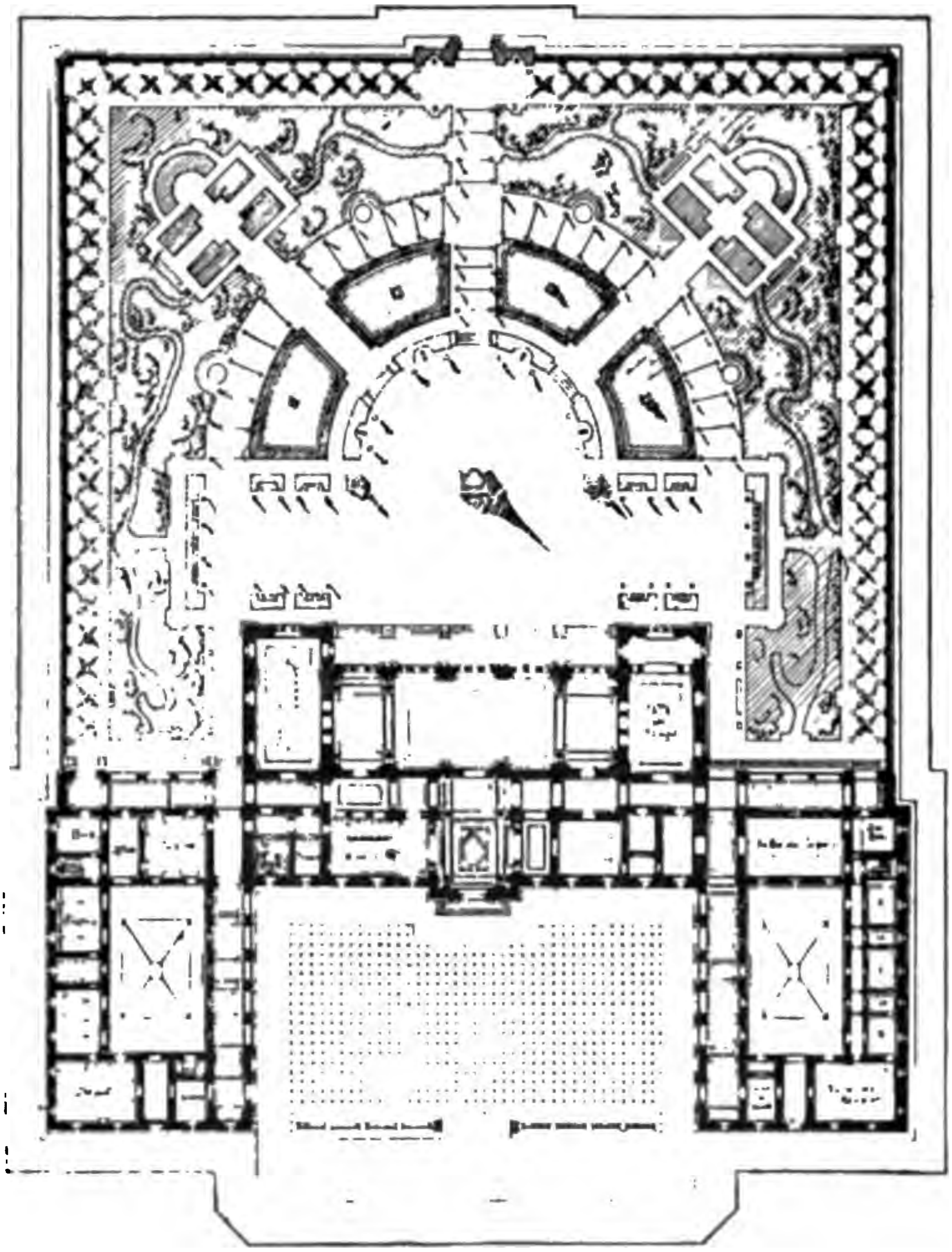

MAY 1905
RESIDENCE FOR MISS F. E. DURAND & MRS. WM. C. WHITE. LAKE DRIVE, MILWAUKEE, WIS.
FERNEKES & CRAMER ARCHTS

COLONIAL RESIDENCE FOR MISS DURAND AND MRS. WHITE, MILWAUKEE, WISCONSIN

Fernekes and Cramer, Architects, Milwaukee, Wisconsin

Walls veneered with continental brick laid Flemish bond

Shingled roof and wood trim   Cost, $17,000



AN APPLICATION [illegible] INDICATING
[illegible]

[illegible]

EXAMINATION PLATES.

Before attempting to render the drawings in ink, the student is advised to practice both with pencil and ink, as such practice will prove a good investment of time.

PLATE I.

In order to get quickly into the practice, the student will be asked to make a copy of this rendering, Fig. A. Do not try to copy too exactly, but use the same freedom.

Observe that the dark accent is obtained by the large shadow and the end of the long shadow just over it. The dark rendering in the window is brought into the group also.

Having thus formed the accent, it is best that the shadow under the hood in the roof should be made rather light, lest it come into competition with the porch shadow. If the student prefers he may make it a trifle darker than here shown.

A little clapboard rendering is put in on the left, to make still more evident the large light, which occurs mainly on the roof but at the same time takes in other white spaces at that end of the drawing.

PLATE II.

This subject introduces a roof rendering, also a simple treatment of windows and blinds. Here the roof serves as a half-tone value. The shadow of the eaves and some of the blinds are the black values. To get the dark accent, the nearest blinds and the near portion of the shadow on the eaves are made very dark.

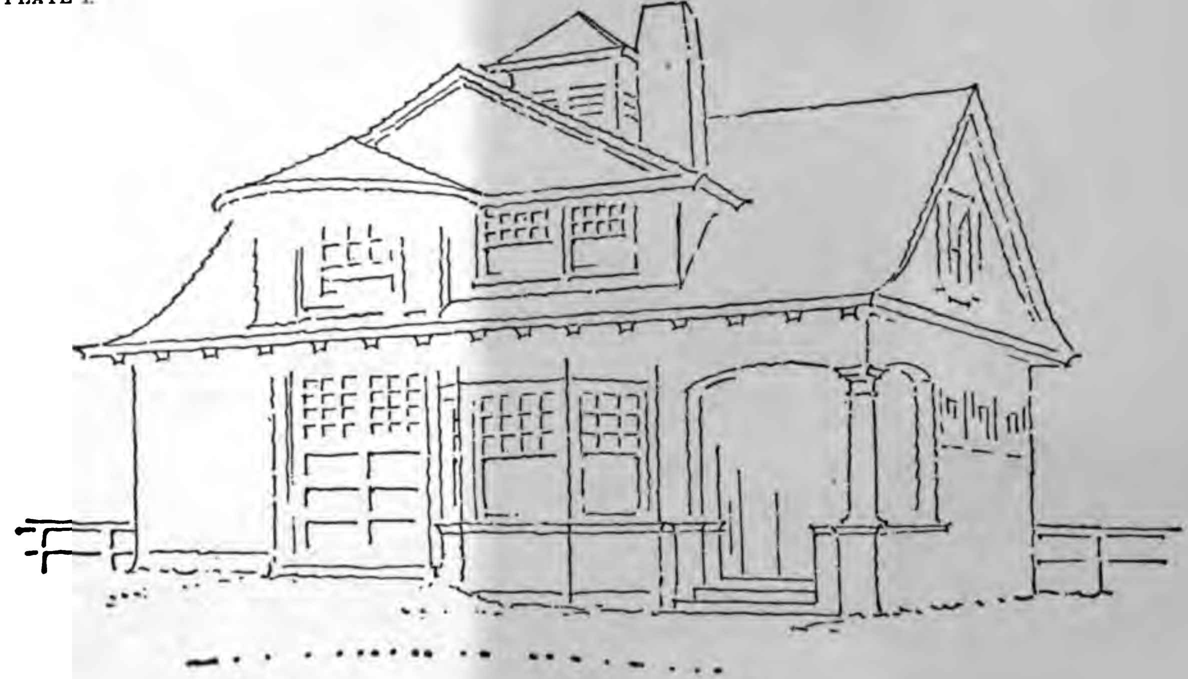
The shadow under the porch shows how safely much of the detail of the door itself may be omitted and not be missed. A broad treatment is better than a fussy one. Observe that the roof lines are made as free as possible, avoiding a straight, wiry line.

After copying this plate original work may be attempted.

PLATES III AND IV.

Make the shadows only for the first rendering, Plate III, just as shown in this value scheme, Fig. C. Then make a second drawing of the same, Plate IV, and give a half tone to the front area of the roof, and to the end of the roof a darker value, as shown in suggestion in upper corner. Finally on this second

PLATE I.



OUTLINE DRAWING READY FOR RENDERING.

All lines should be very light so as not to show through rendering.

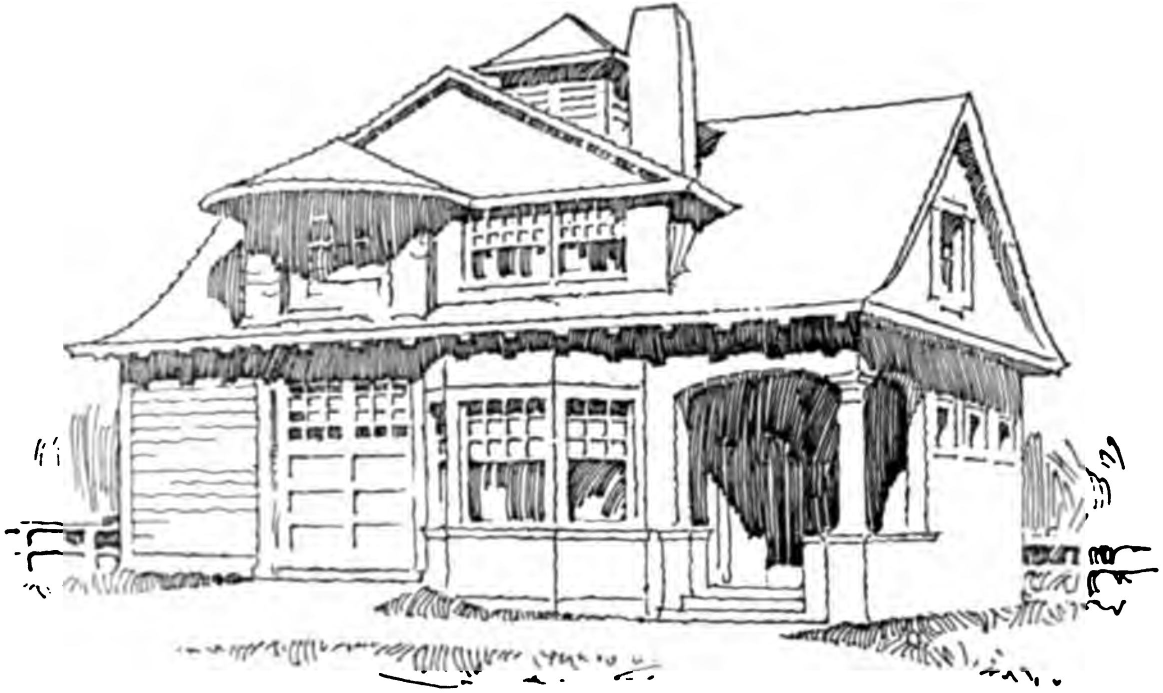
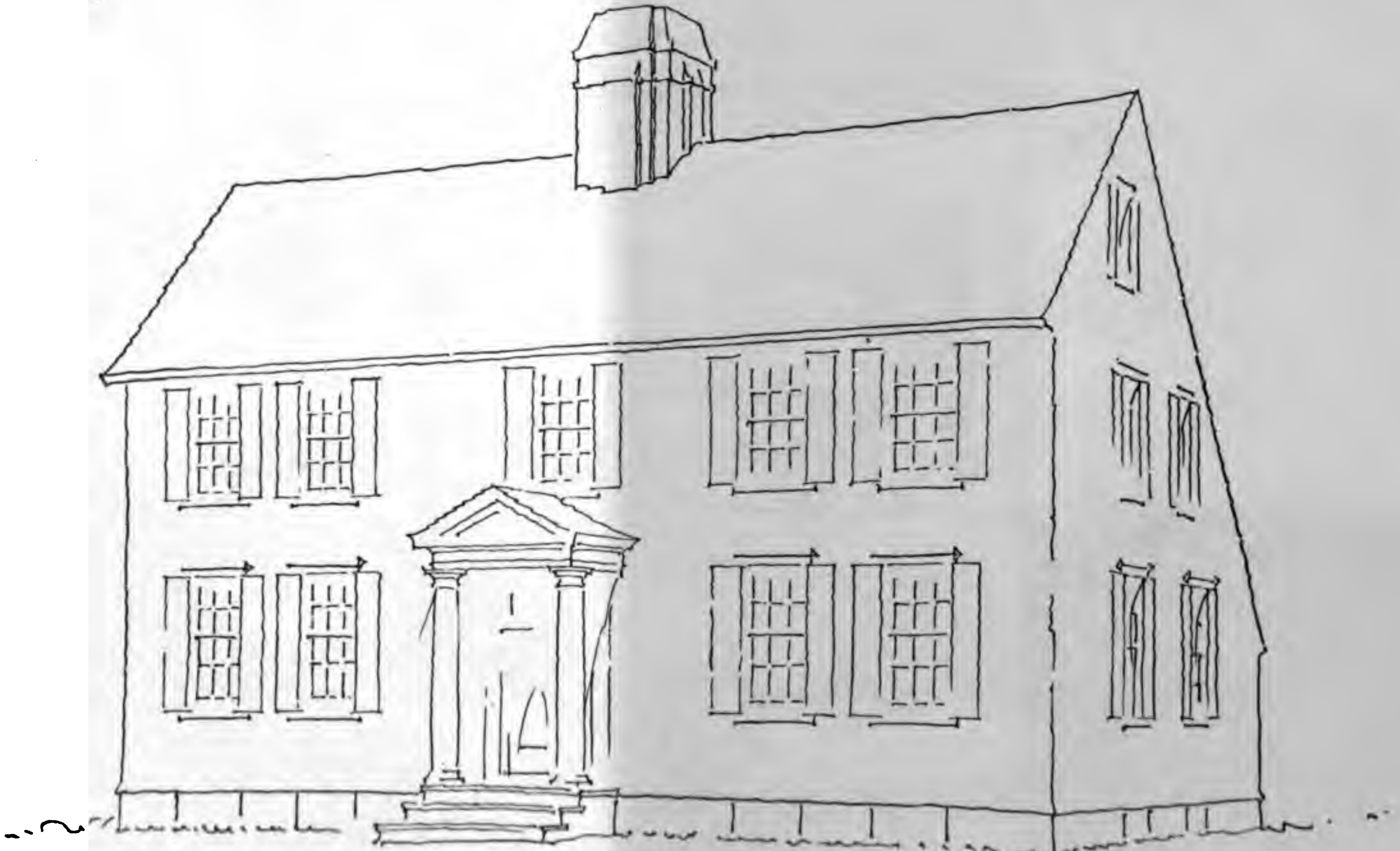


Fig A. (For Plate I.)

FINISHED DRAWING.

PLATE II.



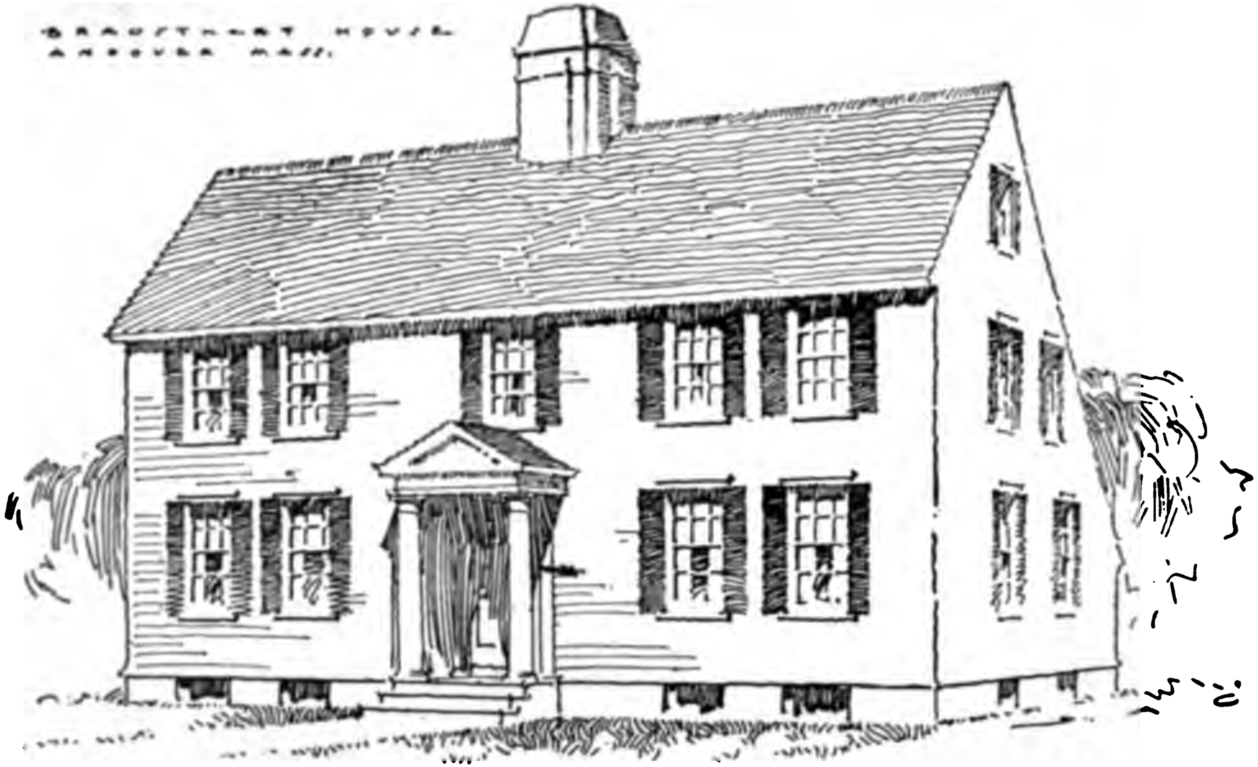


Fig. B. (For Plate II.)

PLATE III.

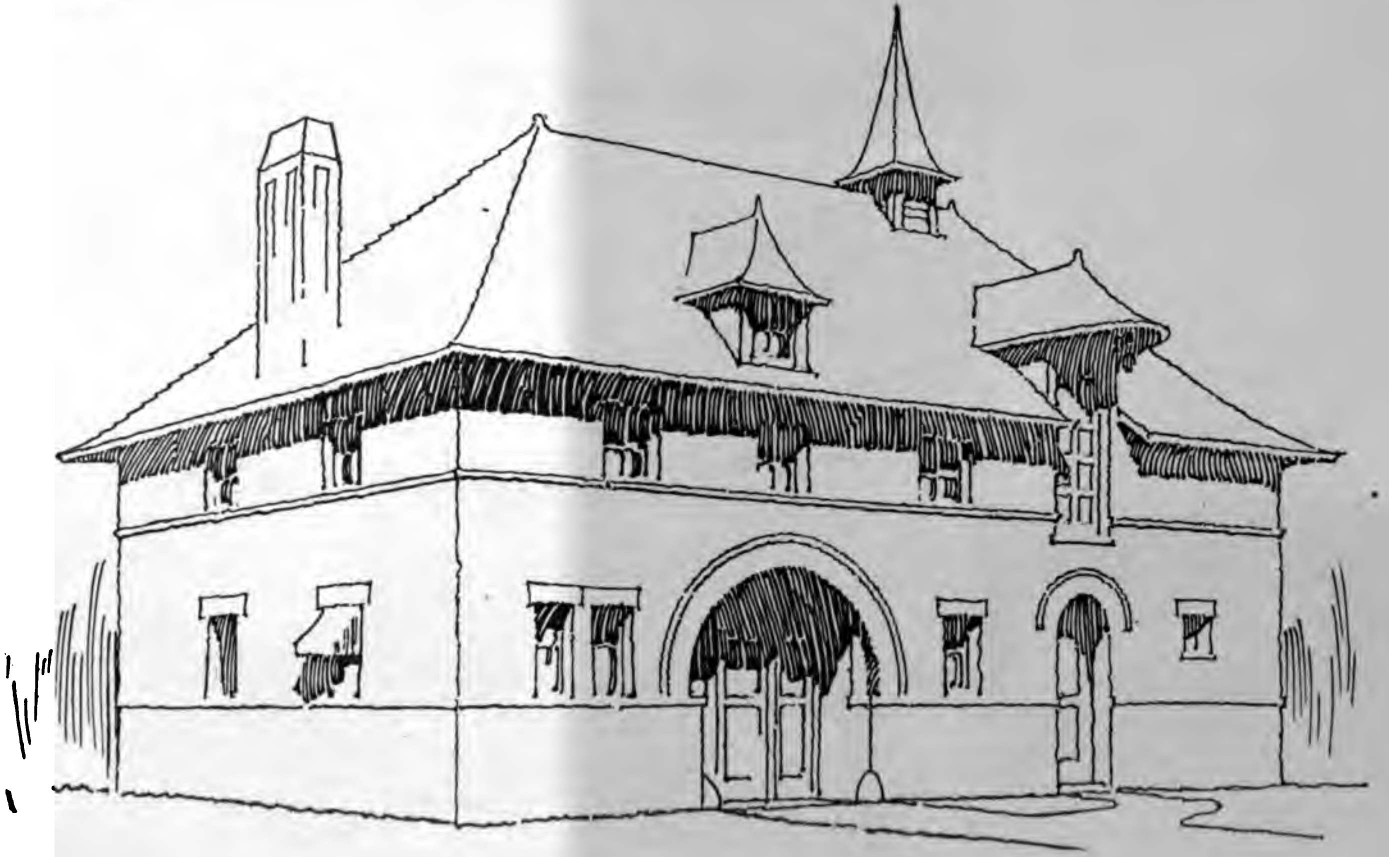
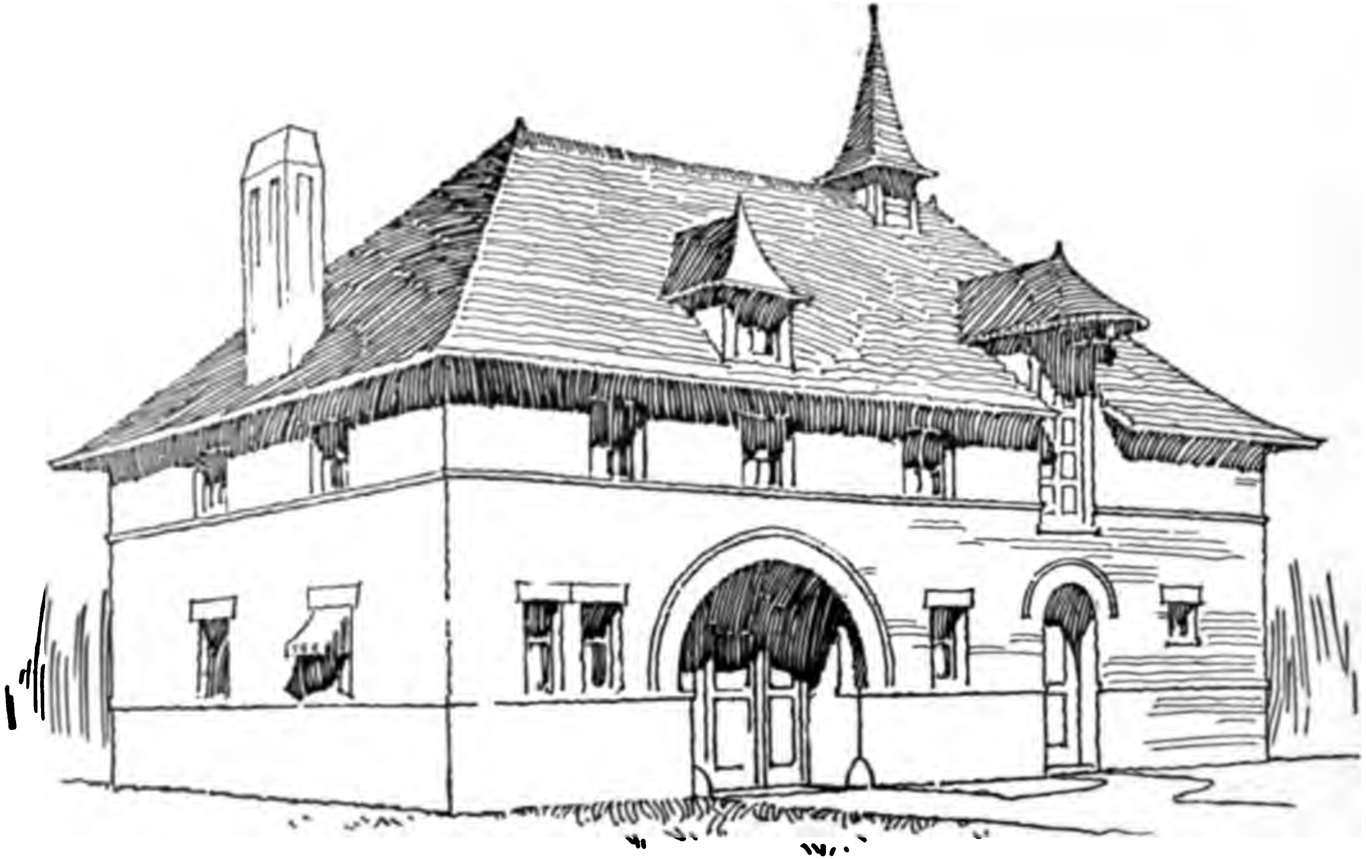


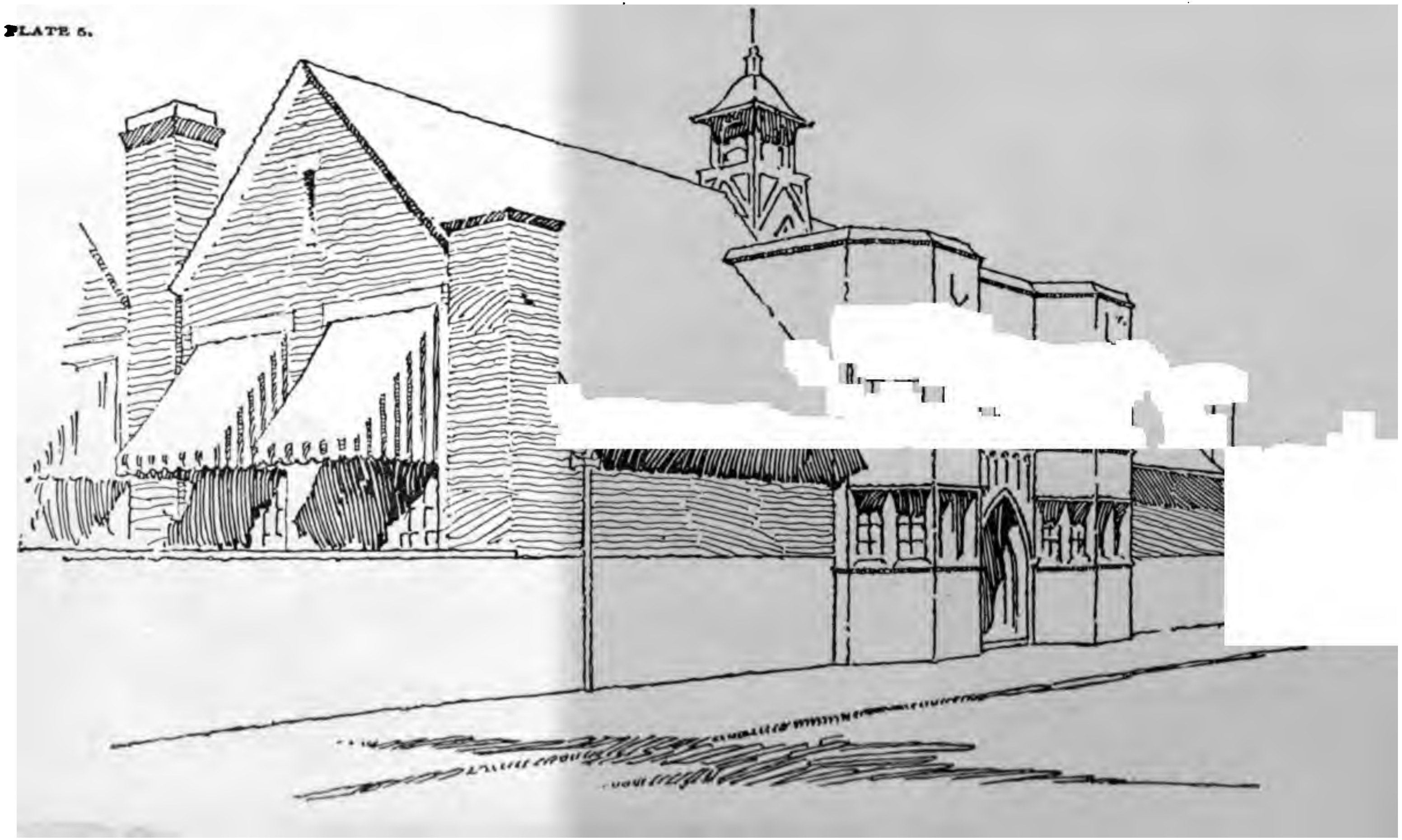
PLATE 6



TWO DIFFERENT TREATMENTS OF SAME SUBJECT

(See opposite page.)

PLATE 5.



drawing, put a small amount of rendering on the wall at the distant right, in the same manner as on Plate II. This will give a large white light on the walls nearest the observer. The long shadows under the eaves should be darkest at the corner nearest the observer and gradually lighten up as it approaches either end.

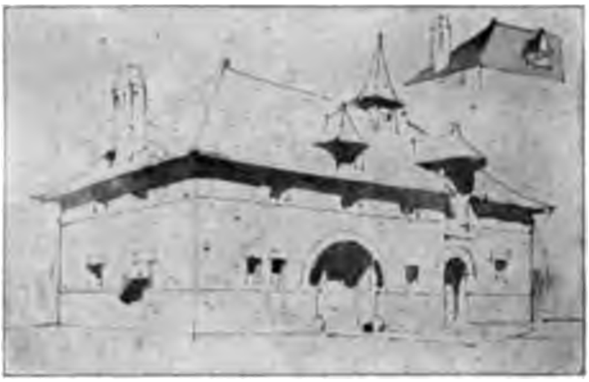


Fig. C. (For Plates III and IV.)

PLATE V.

Put in the shadows first. Get the nearest shadows very dark; then give a half-tone rendering to the whole of the brick-wall surface. Do not ink in the lines at the edges of the brick walls. Let

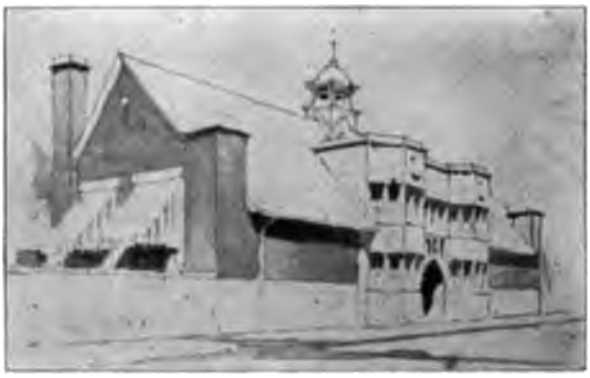


Fig. D. (For Plate V.)

your rendering make the edge as shown in Fig. 18. An outline in such a place produces a mechanical looking rendering, as is seen in the illustration. Outlining is absolutely necessary where there is no rendering, but in connection with it, omit the outline, if possible.

PLATE VI.

The doorway shadow selects for itself the honor of being the leading accent; the shadows at left and right simply repeat it in a small way. The roof affords an opportunity for half-tone. The grass, which may be rendered as illustrated in the two preceding examples, gives also an additional half-tone value. To retain or produce a large light area, the stone jointing should be omitted on the upper portion of the wall, as indicated in the scheme. The roof may be rendered in a free line method, as shown in the sketch. With a good quality of line, and a free, vigorous method, this drawing will be a brilliant one, as its composition of values is favorable.

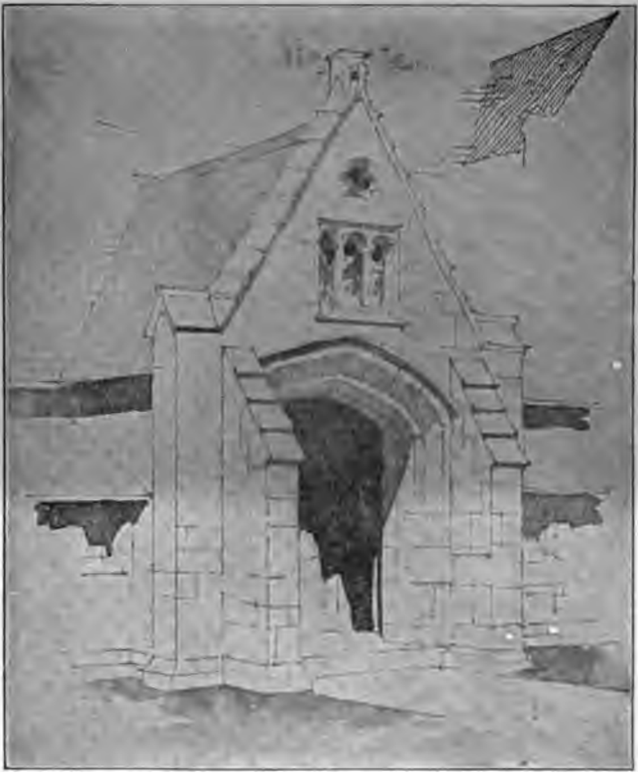
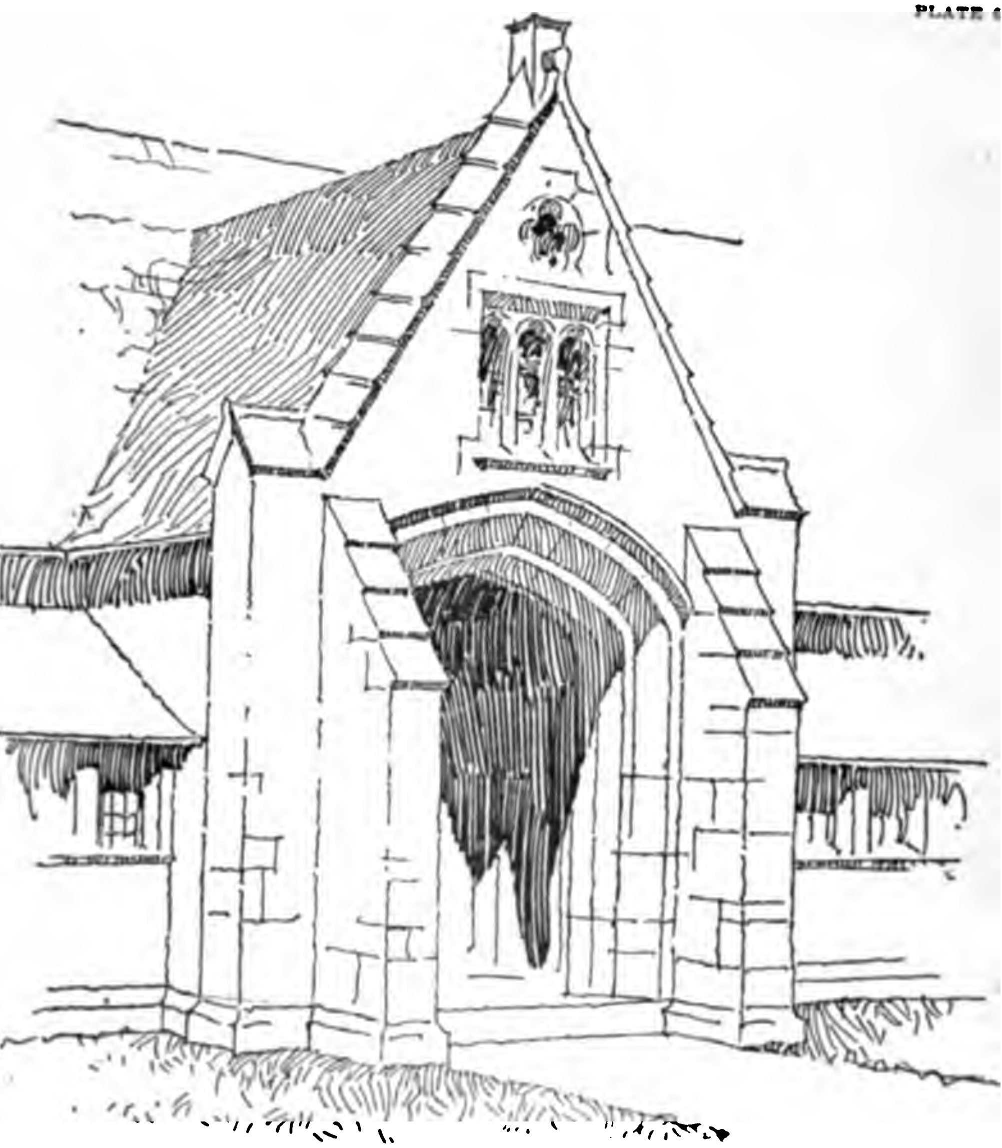
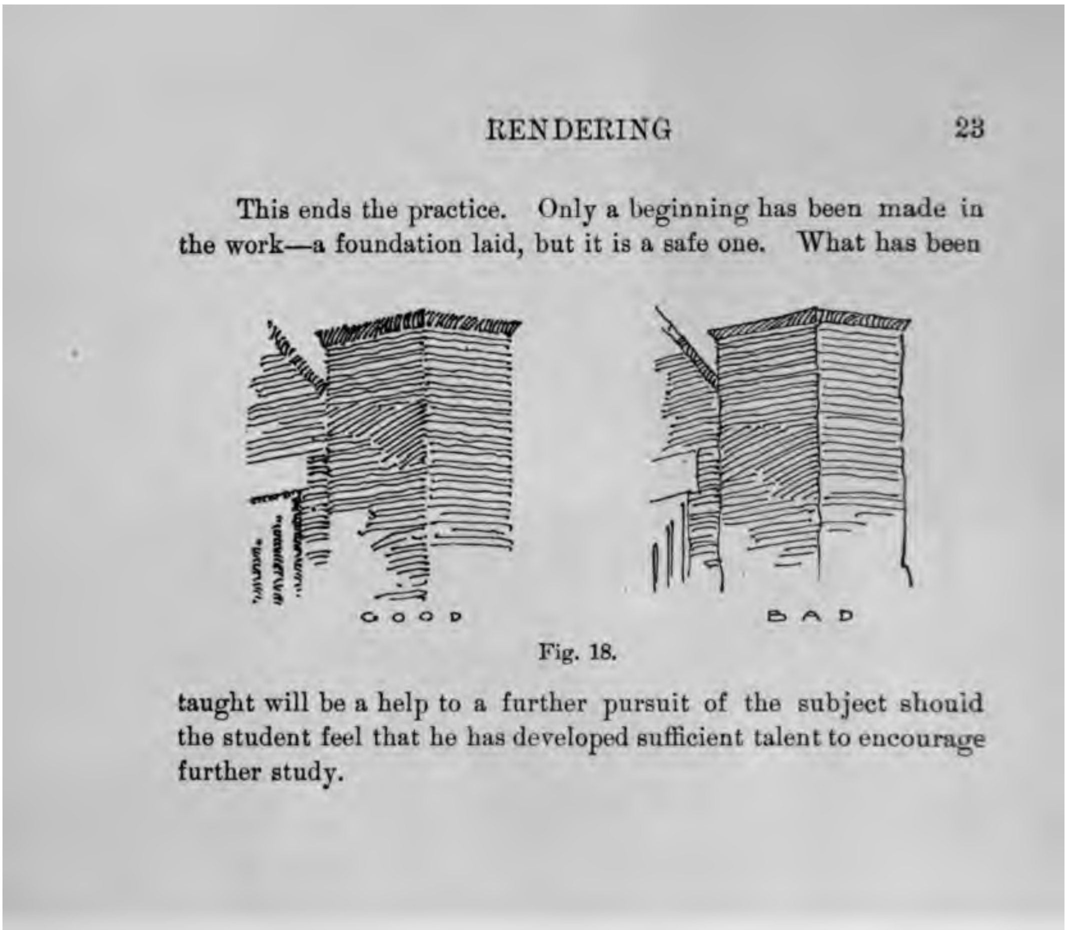


Fig. E. (For Plate VI.)

PLATE 6.

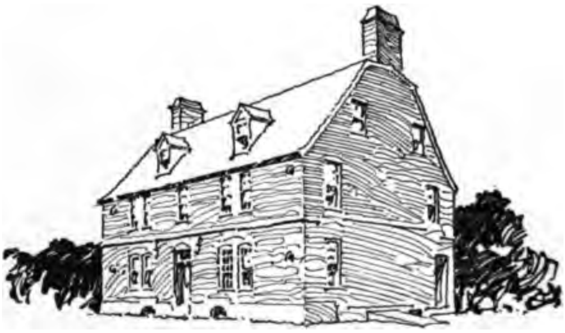




RENDERING 23

This ends the practice. Only a beginning has been made in the work—a foundation laid, but it is a safe one. What has been taught will be a help to a further pursuit of the subject should the student feel that he has developed sufficient talent to encourage further study.

Fig. 18.



Suggestion for treatment of house showing roof in light with half-tone value to walls.

INDEX

INDEX

The page numbers of this volume will be found at the bottom of the pages; the numbers at the top refer only to the section.

Page

A

Alphabet (complete) 147
Alphabet of modern capital letters 150
Alphabet of uncial Gothic capital letters, 16th century 154
Architects' scale 15
Architectural design, preliminary studies in 47
  ideas on paper 47
  methods of 47
  tracing paper, use of 48
Architectural drawing 11-112
  architectural design, preliminary studies in 47
  axes in architectural drawing, importance of 21
  colonial house 71
  definitions 20
  design, practical problems in 57
  drawing boards 12
  dwelling, design of 61
  erasers 11
  exhibition drawings 50
  house, various stages in building 65
  instruments, set of 12
  instruments and materials 11
  line drawing 17
  measured work 53
  offices, buildings for 70
  paper 13
  pencils 11
  rendering in wash 33
    distinction between different planes 42
    graded tints 40
    handling brush 36
    inking drawing 34

Page

Architectural drawing (continued)
  rendering in wash
    laying washes 36
    materials 33
    preparing the tint 35
    rendering elevations 39
    rendering sections and plans 40
    stretching paper 34
  scales 14
  school of fine arts, Paris 48
  sketching 50
  tracing cloth 14
  tracing paper 14
  triangles and T-squares 13
  tinted papers 13
  wash-drawings, materials for 13
  water color hints 42
Architectural inscription lettering 140
Architectural lettering 115-163
  architectural inscription lettering 140
  classic Roman letters 142
  Gothic lettering 159
  letter forms 116
  minuscule or small letters 138
  office lettering 115
  spacing 137
Axes in architectural drawing, importance of 21
  limiting lines 25
  modeling 28
  oblique projections 26
  shadows at 45 degrees 28
  values 29

B

Baluster 26
Block-letter alphabet 150

Note —For page numbers see foot of pages.

Page

C

Classic Roman alphabet 143
Classic Roman inscriptions, fragments of 144
Classic Roman letters 142
Colonial house 71
  attic framing plan 87
  attic and roof plan 81
  basement plan 76
  conditions 71
  elevations 72
  first-floor framing plan 87
  first-floor plan 76
  framing of front elevation 93
  framing of side elevation 93
  front elevation, detail of 85
  front and side elevations 81
  kitchen, pantry, and china closet 97
  main cornice and dormer 97
  plans 72
  plumbing 97
  porch and front entrance 105
  roof framing plan 93
  second-floor framing plan 87
  second-floor plan 78
  sketches 71
  staircase and fireplace details 107
  trim on first floor 105
  uniform titles for drawings 105
  useful memoranda 72
  window frames, detail of 99
Curves 290

D

Design, practical problems in 57
  composition 57
  criticism 60
  ornament 60
  scale 58
  theory of 57
Distortion 294
Drawing boards 12
Dwelling, design of 61
  bathroom 64
  butler's pantry 63

Page

Dwelling, design of (continued)
  cellar 64
  closets 64
  dining room 63
  hallway 61
  kitchen 63
  lavatory 64
  living rooms 62
  number of rooms 61
  refrigerator 63
  sitting room 62
  stairways 62
  storeroom 64

E

Elevations, definition of 21
English Gothic text 161
English 17th century letters from tombstones 156
Erasers 11
Exhibition drawings 50

F

Freehand drawing 165–226
  definition of 165
  exercises (first) 173
    circles and ellipses 174
    freehand perspective 176
    slate, tracing on 176
    slate, testing with 177
    straight lines 173
  freehand perspective 179
    concentric circles 188
    cone 186
    cross hatching 199
    cylinder 184
    drawings, testing of 191
    ellipse 187
    equal spaces 183
    examination plates 197
    foreshortened planes and lines 180
    form drawing 194
    frames 188
    hexagon (regular) 187
    horizon line or eye level 179
    horizontal circle 181

Note.—For page numbers see foot of pages.

Page

- Freehand drawing (continued)
  - freehand perspective
    - light and shade 194
    - objects 190
    - parallel lines 182
    - prism 184
    - shade lines 199
    - shading 198
    - square 182
    - tests, misuse of 193
    - triangle 183
    - value drawing 194
    - value scale 195
    - values 195
  - learning to see 168
  - materials 170
    - holding pencil 172
    - paper 172
    - pencils 170
    - position 173
  - outline 168
  - plates 201–226
  - restraint in 167
  - value of 165

G

- German black letters 158
- Gothic lettering 159

H

- House, various stages in building 65
  - contract, letting of 69
  - full-size details 67
  - materials, representation of 68
  - sketches 65
  - tracing and blue-printing 69
  - working drawings 66

I

- Inscription letter sections 155
- Italian black letters 160
- Italian Renaissance inscription, Chiaravelle Abbey in Milan 153
- Italian Renaissance inscription fragment of 149
- Italian Renaissance inscription at Bologna 153
- Italian Renaissance lettering 152

L

- Letter forms 116
  - advertising announcement 135
  - advertising design 131
  - alphabet 117
  - book cover 136
  - cover announcement 132
  - drawing for Otis memorial arch 130
  - Italian Renaissance alphabet 121
  - letters for architectural office use 125
  - single-line italic letters 126
  - "skeleton" construction of letters 122
  - title page 134
- Lettering from bronze plate in Cathedral Church at Wurzburg 151
- Lettering from Harvard architectural building 146
- Line drawing 17
  - character of line 17

M

- Measured work 53
  - approximations 55
  - arches 54
  - datum lines 53
  - elevation measurements 54
  - hand level 53
  - inaccessible portions 55
  - materials 53
  - measuring tapes 53
  - projections 55
  - rubbings 55
- Measures, lines of 257
  - auxiliary line of 257
- Minuscule or small letters 138

O

- Oblique lines, vanishing points of 208
- Office lettering 115
- Offices, buildings for 70

Note.—For page numbers see foot of pages.